D E C L A R A T I O N

I, Noboru Tanaka, residing at 7 th Fl., Kioicho Park Bldg., 3-6, Kioicho, Chiyoda-ku, Tokyo, Japan, hereby declare that I have a thorough knowledge of Japanese and English languages, and that the attached pages contains a correct translation into English of the application document of Japanese Patent Application No. 2003-028668 filed on February 5, 2003 in the name of CANON KABUSHIKI KAISHA.

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statement were made with the knowledge that willful false statements and the like so made, are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Signed this 19th day of January, 2009

N. Tanaka

Noboru Tanaka

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[Inventor(s)]	
[Address/Domicile]	c/o CANON KABUSHIKI KAISHA 3-30-2, Shimomaruko, Ohta-ku, Tokyo, Japan
[Name]	Takuya Shimada
[Applicant for Patent]	
[Identification Number]	000001007
[Name]	CANON KABUSHIKI KAISHA
[Agent]	
[Identification Number]	100076428
[Patent Attorney]	
[Name]	Yasunori Ohtsuka
[Telephone]	03-5276-3241
[Selected Agent]	
[Identification Number]	100112508
[Patent Attorney]	
[Name]	Jiro Takayanagi
[Telephone]	03-5276-3241
[Selected Agent]	
[Identification Number]	100115071
[Patent Attorney]	
[Name]	Yasuhiro Ohtsuka
[Telephone]	03-5276-3241
[Selected Agent]	
[Identification Number]	100116894
[Patent Attorney]	
[Name]	Shuji Kimura
[Telephone]	03-5276-3241
[Detail of Fee(s)]	

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[Title of the Invention] EXPOSURE DECIDING METHOD

[What Is Claimed Is:]

[Claim 1] A color conversion method of an image processing apparatus for converting an input monochrome signal into a color signal on a predetermined color space A, comprising:

a setting step of setting a tincture adjustment value used to adjust the monochrome signal to a desired tincture of a user;

an acquisition step of acquiring color reproduction characteristics which depend on an image output apparatus and a recording medium;

a first conversion step of converting the input monochrome signal into a first color signal using the color reproduction characteristics acquired in the acquisition step;

a second conversion step of converting the input monochrome signal or the color signal converted in the first conversion step into a second color signal using the tincture adjustment value set in the setting step and the color reproduction characteristics acquired in the acquisition step;

a third conversion step of converting the color signal converted in the second conversion step into a third color signal; and

an output step of forming and outputting a color

signal on the color space A on the basis of the color signal converted in the third conversion step and the color signal converted in the first conversion step.

[Claim 2] The method according to claim 1, wherein the color signal on the color space A is expressed by a lightness value, and a chromaticity point which pertains to hue and saturation attributes.

[Claim 3] The method according to claim 2, wherein the setting step includes a step of setting, as the tincture adjustment value, a chromaticity point on the color space A corresponding to a predetermined monochrome signal and a change rate of a chromaticity point on the color space A associated with a monochrome signal.

[Claim 4] The method according to claim 3, wherein the acquisition step includes a step of acquiring, as the color reproduction characteristics, color signals on the color space A, which correspond to monochrome signals indicating white and black.

[Claim 5] The method according to claim 3 or 4, wherein in the setting step, the predetermined monochrome signal is a monochrome signal corresponding to middle lightness, and the change rate of the chromaticity point is a change rate of chromaticity points associated with monochrome signals of highlight and shadow parts.

[Claim 6] The method according to claim 4 or 5,

wherein in the setting step, the change rate of the chromaticity point is, on the color space A, a change rate of distance on a line segment L in association with a monochrome signal, when the line segment L represents a line segment which connects the chromaticity point, which corresponds to the monochrome signal indicating white acquired in the acquisition step, the chromaticity point set in the setting step, and the chromaticity point, which corresponds to the monochrome signal indicating black acquired in the acquisition step.

[Claim 7] The method according to claim 6, wherein the first conversion step includes a step of converting the input monochrome signal into a color signal indicating a lightness value on the color space A,

the second conversion step includes a step of converting the input monochrome signal or the color signal converted in the first conversion step into a color signal indicating a distance on the line segment L,

the third conversion step includes a step of converting the color signal converted in the second conversion step into a color signal indicating a chromaticity point on the color space A, and

the output step includes a step of forming and outputting the color signal on the color space A, on the basis of the color signal which is converted in the

first conversion step and indicates the lightness value on the color space A, and the color signal which is converted in the third conversion step and indicates the chromaticity point on the color space A.

[Claim 8] The method according to claim 7, wherein the color space is a CIE/L*a*b* color space on which a lightness value is represented by L* and a chromaticity point is represented by a* and b*.

[Claim 9] The method according to claim 7 or 8, wherein the setting step includes a step of setting the chromaticity point and the chromaticity point change rate within predetermined ranges.

[Claim 10] A program for causing a computer to execute a color conversion method of an image processing apparatus recited in any one of claims 7 to 9.

[Claim 11] A profile generation apparatus for generating a profile which stores a relationship between monochrome signals and color signals on a predetermined color space A, comprising:

setting means for setting a tincture adjustment value used to adjust monochrome signals to a desired tincture of a user;

acquisition means for acquiring color reproduction characteristics which depend on an image output apparatus and a recording medium;

generation means for generating discrete monochrome signals;

first conversion means for converting the monochrome signals generated by said generation means into first color signals using the color reproduction characteristics acquired by said acquisition means;

second conversion means for converting the monochrome signals generated by said generation means or the color signals converted by said first conversion means into second color signals using the tincture adjustment value set by said setting means and the color signals acquired by said acquisition means;

third conversion means for converting the color signals converted by said second conversion means into third color signals; and

output means for generating and outputting a profile on the basis of the color signals converted by said third conversion means and the color signals converted by said first conversion means,

wherein the color signal on the color space A is expressed by a lightness value, and a chromaticity point which pertains to hue and saturation attributes,

said setting means sets, as the tincture adjustment value, a chromaticity point on the color space A corresponding to a predetermined monochrome signal and a change rate of a chromaticity point on the color space A associated with monochrome signals,

said acquisition means acquires, as the color reproduction characteristics, color signals on the

color space A, which correspond to monochrome signals indicating white and black,

in said setting means, the predetermined monochrome signal is a monochrome signal corresponding to middle lightness,

the change rate of the chromaticity point is a change rate of chromaticity points associated with monochrome signals of highlight and shadow parts,

in said setting means, the change rate of the chromaticity point is, on the color space A, a change rate of distance on a line segment L in association with a monochrome signal, when the line segment L represents a line segment which connects the chromaticity point, which corresponds to the monochrome signal indicating white acquired by said acquisition means, the chromaticity point set by said setting means, and the chromaticity point, which corresponds to the monochrome signal indicating black acquired by said acquisition means,

said first conversion means converts the monochrome signal generated by said generation means into a color signal indicating a lightness value on the color space A,

said second conversion means converts the monochrome signal generated by said generation means or the color signal converted by said first conversion

means into a color signal indicating a distance on the line segment L,

said third conversion means converts the color signal converted by said second conversion means into a color signal indicating a chromaticity point on the color space A, and

said output means forms and outputs the color signal on the color space A, by using the color signal which is converted by said first conversion means and indicates the lightness value on the color space A, and the color signal which is converted by said third conversion means and indicates the chromaticity point on the color space A.

[Claim 12] The apparatus according to claim 11, wherein said setting means sets the chromaticity point and the chromaticity point change rate within predetermined ranges.

[Claim 13] A program for causing a computer to execute a profile generation method of a profile generation apparatus recited in claim 11 or 12.

[Claim 14] An image conversion apparatus for converting input monochrome image data into color image data for an image output apparatus designated, comprising:

setting means for setting a tincture adjustment value used to adjust the monochrome image data to a desired tincture of a user;

acquisition means for acquiring color reproduction characteristics which depend on the image output apparatus and a recording medium;

first conversion means for converting monochrome signals which form the input monochrome image data into first color signals using the color reproduction characteristics acquired by said acquisition means;

second conversion means for converting monochrome signals which form the input monochrome image data or the color signals converted by said first conversion means into second color signals using the tincture adjustment value set by said setting means and the color signals acquired by said acquisition means;

third conversion means for converting the color signals converted by said second conversion means into third color signals; and

outputting means for generating and outputting the color image data for the image output apparatus on the basis of the color signals converted by said third conversion means and the color signals converted by said first conversion means using the color reproduction characteristics acquired by said acquisition means,

wherein the color signal on the color space A is expressed by a lightness value, and a chromaticity point which pertains to hue and saturation attributes,

said setting means sets, as the tincture

adjustment value, a chromaticity point on the color space A corresponding to a predetermined monochrome signal and a change rate of a chromaticity point on the color space A associated with monochrome signals,

said acquisition means acquires color signals on the color space A, which correspond to discrete color signals including color signals indicating white and black of the image output apparatus,

in said setting means, the predetermined monochrome signal is a monochrome signal corresponding to middle lightness,

the change rate of the chromaticity point is a change rate of chromaticity points associated with monochrome signals of highlight and shadow parts,

in said setting means, the change rate of the chromaticity point is, on the color space A, a change rate of distance on a line segment L in association with a monochrome signal, when the line segment L represents a line segment which connects the chromaticity point, which corresponds to the monochrome signal indicating white acquired by said acquisition means, the chromaticity point set by said setting means, and the chromaticity point, which corresponds to the monochrome signal indicating black acquired by said acquisition means,

said first conversion means converts the monochrome signals which form the input monochrome

image data into color signals indicating a lightness value on the color space A,

said second conversion means converts the monochrome signals which form the input monochrome image data or the color signals converted by said first conversion means into color signals indicating a distance on the line segment L,

said third conversion means converts the color signals converted by said second conversion means into color signals indicating a chromaticity point on the color space A, and

said output means generates and outputs the color image data for the image output apparatus on the basis of the color signal which is converted by said first conversion means and indicates the lightness value on the color space A, and the color signal which is converted by said third conversion means and indicates the chromaticity point on the color space A, using the color reproduction characteristics acquired by said acquisition means.

[Claim 15] The apparatus according to claim 14, wherein said setting means sets the chromaticity point and the chromaticity point change rate within predetermined ranges.

[Claim 16] A program for causing a computer to execute an image conversion method of an image conversion apparatus recited in claim 14 or 15.

[Claim 17] An image processing apparatus for converting monochrome signals which form the input monochrome image data into color signals for a connected image output apparatus, comprising:

setting means for setting a tincture adjustment value used to adjust the monochrome image data to a desired tincture of a user;

acquisition means for acquiring color reproduction characteristics which depend on the image output apparatus and a recording medium;

first conversion means for converting monochrome signals which form the input monochrome image data into first color signals using the color reproduction characteristics acquired by said acquisition means;

second conversion means for converting monochrome signals which form the input monochrome image data or the color signals converted by said first conversion means into second color signals using the tincture adjustment value set by said setting means and the color reproduction characteristics acquired by said acquisition means;

third conversion means for converting the color signals converted by said second conversion means into third color signals; and

outputting means for converting the color signals converted by said third conversion means and the color signals converted by said first conversion means into

the color image data for the image output apparatus using the color reproduction characteristics acquired by said acquisition means, and outputting the converted color signals,

wherein the color signal on the color space A is expressed by a lightness value, and a chromaticity point which pertains to hue and saturation attributes,

said setting means sets, as the tincture adjustment value, a chromaticity point on the color space A corresponding to a predetermined monochrome signal and a change rate of a chromaticity point on the color space A associated with monochrome signals,

said acquisition means acquires color signals on the color space A, which correspond to discrete color signals including color signals indicating white and black of the image output apparatus,

in said setting means, the predetermined monochrome signal is a monochrome signal corresponding to middle lightness,

the change rate of the chromaticity point is a change rate of chromaticity points associated with monochrome signals of highlight and shadow parts,

in said setting means, the change rate of the chromaticity point is, on the color space A, a change rate of distance on a line segment L in association with a monochrome signal, when the line segment L represents a line segment which connects the

chromaticity point, which corresponds to the monochrome signal indicating white acquired by said acquisition means, the chromaticity point set by said setting means, and the chromaticity point, which corresponds to the monochrome signal indicating black acquired by said acquisition means,

said first conversion means converts the monochrome signals which form the input monochrome image data into color signals indicating a lightness value on the color space A,

said second conversion means converts the monochrome signals which form the input monochrome image data or the color signals converted by said first conversion means into color signals indicating a distance on the line segment L,

said third conversion means converts the color signals converted by said second conversion means into color signals indicating a chromaticity point on the color space A, and

said output means generates and outputs the color image data for the image output apparatus on the basis of the color signal which is converted by said first conversion means and indicates the lightness value on the color space A, and the color signal which is converted by said third conversion means and indicates the chromaticity point on the color space A, using the color reproduction characteristics acquired by said

acquisition means.

[Claim 18] The apparatus according to claim 17, wherein said setting means sets the chromaticity point and the chromaticity point change rate within predetermined ranges.

[Claim 19] A program for causing a computer to execute an image conversion method of an image processing apparatus recited in claim 17 or 18.

[Claim 20] A computer-readable recording medium in which the program recited in any one of claims 10, 13, 16 and 19 is recorded.

[Claim 21] A tincture conversion method of an image processing apparatus for converting input monochrome signals into color signals for an image output apparatus, comprising:

a setting step of setting a tincture adjustment value used to adjust monochrome signals to a desired tincture of a user when the input monochrome signals are converted into color signals for the image output apparatus;

a generation step of generating a profile which converts the input monochrome signals into the color signals for the image output apparatus on the basis of the tincture adjustment value set in the setting step and a profile of the image output apparatus; and

a conversion step of converting the input monochrome signals into the color signals for the image

output apparatus using the profile generated in the generation step.

[Detailed Description of the Invention]

[0001]

[Technical Field to Which the Invention Belongs]

The present invention relates to a technique for converting an input monochrome signal into color signals of an image output apparatus.

[0002]

[Prior Art]

In recent years, use of digital color images has increased abruptly along with the popularization of digital cameras. Photo print techniques for satisfactorily printing these images have been extensively developed. On the other hand, in the field of silver halide photos, it has been prevalent to take monochrome photos using vintage cameras. Monochrome photos, unlike color photos, express an object's texture by subtle flavor and expressive power, are used as an expressive means different from that of color photos. Digital monochrome images are not so currently prevalent compared to color photos. If digital cameras are used as the same expression means as monochrome photos in the future, however, expansion of the usage of digital monochrome images are expected.

[0003]

In general, a monochrome image is printed by

forming an image using a black color agent (ink or toner). When an image is formed using a black color agent alone, however, the color characteristics of the black color agent practically determine the tincture of a printed image. Hence, the tincture of a printed image cannot be controlled in order to be reproduced desirably.

[0004]

A monochrome image is also often formed by a so-called "composite black", using color agents such as, inter alia, cyan (hereinafter abbreviated as C), magenta (hereinafter abbreviated as M), yellow (hereinafter abbreviated as Y), in addition to black (hereinafter abbreviated as K). In these cases, by combining color agents at an appropriate ratio, the tincture of a monochrome image can be desirably reproduced. Also, by changing the ratio of combined color agents, the tincture can be adjusted.

[0005]

Furthermore, when a color printer is used to print a monochrome image, the tincture cannot be adjusted unless the printer has a special adjustment function. Hence, when a monochrome image is outputted with a desired tincture, image data is converted into R, G, and B color component signals, which are to be adjusted.

[0006]

[Problems That the Invention Is to Solve]

In the above prior art, however, when the tincture is adjusted by adjusting the color agent amounts or color component signal values, because the relationship between the adjustment amounts and print colors is not always constant, an unexpected adjustment result is often obtained. Some adjustment may also lose a tincture balance at a specific gray level, and the tincture may disproportionately appear. For example, when a tinge of yellow is to be enhanced by increasing the amount of a Y color agent or decreasing a B signal value, the tincture of middle lightness has nearly no change, but an image with excessively yellowish highlight may be formed. Furthermore, some adjustment may often change the brightness of an image.

[0007]

The present invention has been made to solve the aforementioned problems, and has as its object to generate a profile used to print a monochrome image with a tincture of user's choice without any color deviation.

[0008]

It is another object of the present invention to convert monochrome image data into color image data that can be printed with a desired tincture without biasing colors upon printing the monochrome image data by a designated image output apparatus.

[0009]

[Means of Solving the Problems]

In order to achieve the above objects, according to one aspect of the present invention, there is provided a color conversion method of an image processing apparatus for converting an input monochrome signal into a color signal on a predetermined color space A, comprising: a setting step of setting a tincture adjustment value used to adjust the monochrome signal to a desired tincture of a user; an acquisition step of acquiring color reproduction characteristics which depend on an image output apparatus and a recording medium; a first conversion step of converting the input monochrome signal into a first color signal using the color reproduction characteristics acquired in the acquisition step; a second conversion step of converting the input monochrome signal or the color signal converted in the first conversion step into a second color signal using the tincture adjustment value set in the setting step and the color reproduction characteristics acquired in the acquisition step; a third conversion step of converting the color signal converted in the second conversion step into a third color signal; and an output step of forming and outputting a color signal on the color space A on the basis of the color signal converted in the third

conversion step and the color signal converted in the first conversion step.

[0010]

[Embodiments]

Preferred embodiments of the present invention will be described in detail hereinafter with reference to the accompanying drawings.

[0011]

[First Embodiment]

The first embodiment will exemplify an image processing apparatus which generates a profile used to print an input monochrome image in a desired color without any tincture deviation in a print process using a color management system (CMS).

[0012]

<CMS>

Fig. 1 is a view for explaining an overview of a color management system (CMS). The color management system (CMS) is primarily a color processing technique that allows a plurality of image input/output apparatuses (e.g., a color copy 101, color monitor 102, digital camera 103, color printer 104, and the like) to satisfactorily reproduce an identical color image. According to the CMS, a color signal of an input system is converted into that of an output system. More specifically, an input color signal depending on an input system apparatus is converted into a signal on a

color match color space, which is independent of any apparatuses using a predetermined conversion formula or table that pertains to the input system apparatus. The predetermined conversion formula or table used to mutually convert a signal on the color space depending on a given apparatus and a signal on the color match color space in this way is called a "profile" of that apparatus. The converted signal on the color match color space undergoes a predetermined color process to obtain a signal value to be output. The signal value is then converted into a signal on a color space depending on each apparatus of an output system with reference to a profile of that apparatus.

[0013]

As described above, according to the CMS, because a color signal is converted between the color space depending on each apparatus and the color match color space, color matching among a plurality of apparatuses can be realized.

[0014]

Fig. 2 is a block diagram showing an example of an image output system using the CMS. In the image output system shown in Fig. 2, R, G, and B color signals that form image data are converted into C, M, Y, and K color signals of a connected image output apparatus by an input profile conversion unit 201, color mapping unit 202, output profile conversion unit

203, and color separation conversion unit 204.

[0015]

The input profile conversion unit 201 converts input R, G, and B color signals into L*, a*, and b* color signals on a CIELAB color space on the basis of the profile which is stored in an input profile storage unit 205 and represents the color reproduction characteristics of an image input apparatus. The input profile storage unit 205 stores L*, a*, and b* color signals corresponding to discrete R, G, and B color signals as a three-dimensional (3D) lookup table (to be abbreviated as an LUT hereinafter). The input profile conversion unit 201 converts the input R, G, and B color signals into L*, a*, and b* color signals on the CIELAB color space by a known method using that 3D LUT.

[0016]

The color mapping unit 202 converts L, a, and b input signals into L', a', and b' color signals which can be reproduced by the image output apparatus. In this way, when the image input apparatus and image output apparatus have different color gamuts, the color mapping unit 202 can absorb their differences. When the image input apparatus and image output apparatus have equal color gamuts, the input color signals are directly output.

[0017]

The output profile conversion unit 203 converts

input L', a', and b' color signals into R', G', and B' color signals depending on the image output apparatus on the basis of a profile which is stored in an output profile storage unit 206 and represents the color reproduction characteristics of the image output apparatus. Note that the output profile storage unit 206 typically stores L', a', and b' color signals corresponding to discrete R', G', and B' color signals as a 3D LUT. The output profile conversion unit 203 searches that 3D LUT for data near the input L', a', and b' color signals, and calculates output R', G', and B' color signals on the basis of the found data and the input color signals using a known interpolation method.

[0018]

The color separation conversion unit 204 converts the input R', G', and B' color signal into output C, M, Y, and K color signals by a known method using a color separation LUT stored in a color separation LUT storage unit 207. Then, a print image corresponding to the input image data is formed by the image output apparatus (not shown) on the basis of the C, M, Y, and K color signals.

[0019]

In this way, in the image output system using the aforementioned CMS, each of print colors corresponding to the input image data is determined by the input profile stored in the input profile storage unit 205.

The image processing apparatus of the first embodiment generates an input profile used to print a monochrome image with a tincture of user's choice without any tincture deviation upon printing that monochrome image in the image output system using the CMS.

[0020]

<Basic Arrangement>

Fig. 3 is a block diagram showing the basic arrangement of the image processing apparatus in the first embodiment. Referring to Fig. 3, reference numeral 301 denotes a CPU, which controls the overall apparatus using programs and data stored in a RAM and ROM (to be described below), and also executes image processes (to be described later). Reference numeral 302 denotes a RAM which comprises an area for temporarily storing programs and data loaded from an external storage device or recording medium drive, and various data whose processes are underway, and also a work area used when the CPU 301 executes respective processes. Reference numeral 303 denotes a ROM which stores programs, control data, and the like required to control the overall apparatus.

[0021]

Reference numeral 304 denotes an operation unit, which comprises a keyboard and a pointing device such as a mouse, and can input, among others, a gray tincture adjustment instruction, output profile

designation, to this apparatus (to be described later). Reference numeral 305 denotes a display unit which comprises a CRT, liquid crystal display, etc, and displays various adjustment user interfaces (UIs; to be described later), images, and text. Reference numeral 306 denotes an external storage device which saves an operating system (OS), and an image processing program 307 and parameters 308 required to implement various image processes. Reference numeral 309 denotes a recording medium drive, which reads various data including image data from a recording medium, and outputs them to the external storage device 306 and RAM 302. Also, the storage medium drive 309 saves a generated profile. Reference numeral 310 denotes a bus which interconnects the aforementioned units.

[0022]

<Functional Arrangement>

Fig. 4 is a block diagram showing the functional arrangement of the image processing apparatus in the first embodiment. As shown in Fig. 4, the apparatus comprises, as the functional arrangement, a color signal generation module 401, grayscale characteristic conversion module 402, tincture conversion A module 403, tincture conversion B module 404, format module 405, profile acquisition module 406, tincture adjustment value setting module 407, grayscale characteristic holding module 408, tincture conversion

table holding module 409, and chromaticity line table holding module 410.

[0023]

In this arrangement, the color signal generation module 401 generates discrete monochrome signals GL. The grayscale characteristic conversion module 402 converts the monochrome signals GL into print image lightness values L*, obtained when the monochrome signals GL are output by the image output apparatus on the basis of grayscale characteristics stored in the grayscale characteristic holding module 408.

[0024]

Fig. 5 shows an example of the grayscale characteristics stored in the grayscale characteristic holding module 408. The grayscale characteristics are stored as a correspondence table of lightness values L* in association with discrete monochrome signals GL, and are associated print image with brightness. Note that a lightness value L* corresponding to an arbitrary monochrome signal GL is calculated by a known interpolation operation on the basis of the grayscale characteristics.

[0025]

Fig. 6 shows an example of the relationship between the monochrome signal GL and lightness L*. Referring to Fig. 6, the monochrome signal GL is an 8-bit signal. Lmax represents a lightness value L*

which normally corresponds to a maximum value (to be referred to as a white signal hereinafter) GL = 255 of the monochrome signal GL, and Lmin represents a lightness value L* which corresponds to a minimum value (to be referred to as a black signal) GL = 0 of the monochrome signal GL. The values Lmax and Lmin are acquired by the profile acquisition module 406 (to be described later). A lightness value L* corresponding to a monochrome signal GL which meets 0 < GL and GL < 255 is preferably determined on the basis of the values Lmax and Lmin and desired grayscale characteristics.

[0026]

The tincture conversion A module 403 converts each lightness value L* as an input signal into a distance signal l on a chromaticity space (to be described later) on the basis of a tincture conversion table stored in the tincture conversion table holding module 409.

[0027]

Fig. 7 shows an example of the tincture conversion table stored in the tincture conversion table holding module 409. This tincture conversion table is a correspondence table of distance signals l in association with discrete lightness values L*, and is associated with the tincture of a print image. A distance signal l corresponding to an arbitrary lightness value L* is calculated by a known

interpolation operation on the basis of this tincture conversion table.

[0028]

The distance signal 1 and a chromaticity point path (gray line) of the monochrome signal in the profile to be generated will be described in detail below using Fig. 8.

[0029]

Fig. 8 illustrates the chromaticity point path projected onto an a*b* chromaticity plane on the CIELAB color space. Referring to Fig. 8, a point W is a chromaticity point of a print color (white print color) corresponding to the white signal, and a point K is a chromaticity point of a print color (black print color) corresponding to the black signal. The chromaticity points (points W and K) of white and black print colors are acquired by the profile acquisition module 406 (to be described later). A point G is a chromaticity point (gray chromaticity point) of a middle lightness value, which is designated by an adjustment instruction from the tincture adjustment value setting module 407 (to be described later).

[0030]

When a profile is generated so that the gray line passes the gray chromaticity point (point G) designated by the adjustment instruction, as shown in Fig. 8, a monochrome print image with a tincture based on user's

intention can be obtained.

[0031]

This distance signal l indicates a distance along the gray line when the point W is a starting point, and a signal value corresponding to each chromaticity point on the gray line, as shown in Fig. 8. For example, a distance signal lg corresponding to the point G indicates a distance between the points W and G along the gray line, and a distance signal lk corresponding to the point K indicates the sum of the distance signal lg and a distance between the points G and K along the gray line. Also, a distance signal corresponding to the point W is zero.

[0032]

Details of the tincture conversion process in the tincture conversion A module 403 shown in Fig. 4 will be described below using Fig. 9.

[0033]

Fig. 9 shows an example of the relationship between the lightness values L* and distance signals l, which form the tincture conversion table shown in Fig. 7. Referring to Fig. 9, lightness Lmin indicates the lightness value of the black print color. The chromaticity point of that black print color is the point K shown in Fig. 8, and a distance signal l corresponding to lightness Lmin is the distance signal lk in the above example. On the other hand, lightness

Lmax is the lightness value of the white print color. The chromaticity point of that white print color is the point W shown in Fig. 8, and a distance signal l corresponding to lightness Lmax is zero, as described above. A distance signal l corresponding to a middle lightness part (L* that satisfies L1 < L* and L* < L2 in Fig. 9) is the distance signal lg corresponding to the chromaticity point G shown in Fig. 8. In the first embodiment, by generating a profile so that the chromaticity point of the middle lightness part matches the gray chromaticity point (point G shown in Fig. 8) designated by the adjustment instruction, a monochrome print image with a tincture based on user's intention can be obtained.

[0034]

Suppression of tincture changes in highlight and shadow parts will be described below using Fig. 9. Referring to Fig. 9, when the aforementioned middle lightness part has a broad lightness range (i.e., L2 - L1 is large) most of input monochrome signals except for highlight and shadow are reproduced based on the chromaticity point (point G shown in Fig. 8) designated by the adjustment instruction. In this case, however, because the change rate of the distance signal l associated with lightness (i.e., that of the chromaticity point is large in a high lightness part near the white print color and a low lightness part

near the black print color) tincture changes are observed in, among others, gradation images.

[0035]

In the first embodiment, since the tincture adjustment value setting module 407 (to be described later) issues an adjustment instruction of the change rate of the chromaticity point, Φ and θ (angles line segments indicated by the tincture conversion table and a straight line parallel to the L* axis make respectively in the high and low lightness parts) in Fig. 9 are appropriately set, thus generating a profile which suppresses tincture changes of a print image.

[0036]

The tincture conversion B module 404 shown in Fig. 4 converts each distance signal l as an input signal into a chromaticity coordinate signal (a*, b*) on the CIELAB color space on the basis of a chromaticity line table stored in the chromaticity line table holding module 410.

[0037]

Fig. 10 shows an example of the chromaticity line table stored in the chromaticity line table holding module 410. This chromaticity line table is formed by extracting the relationship between distance signals l on the gray line shown in Fig. 8 and chromaticity coordinates (a*, b*) in association with discrete distance signals l. A chromatic coordinate signal (a*,

b*) corresponding to an arbitrary distance signal l is calculated by a known interpolation operation on the basis of this chromaticity line table.

[0038]

The format module 405 converts the input L*, a*, and b* signals into a prescribed format, thus generating a profile. This profile is made up of a 3D LUT (L*, a*, and b* color signals corresponding to discrete R, G, and B color signals), and various kinds of header information. When R, G, and B color signals have equal color signal values (R = G = B), the 3D LUT stores L*, a*, and b* color signals on the basis of the outputs from the grayscale characteristic conversion module 402 and tincture conversion B module 404 when the color signal generation module 401 generates the corresponding monochrome color signals (GL = R = G = B). For other R, G, and B color signals, the 3D LUT stores dummy L*, a*, and b* color signals.

[0039]

The profile acquisition module 406 acquires an output profile of the image output apparatus, and then acquires L*, a*, and b* color signals of white and black print colors, which depend on that image output apparatus and an image recording medium (print paper). The acquired L*, a*, and b* color signals of white and black print colors are used by the grayscale characteristic holding module 408 and the tincture

adjustment value setting module 407 (to be described below).

[0040]

The aforementioned tincture adjustment value setting module 407 sets the tincture conversion table to be stored in the tincture conversion table holding module 409 and the chromaticity line table to be stored in the chromaticity line table holding module 410 on the basis of the chromaticity points of the white and black print colors acquired by the profile acquisition module 406, and a gray chromaticity point (point G shown in Fig. 8) and chromaticity point change rate (values associates with Φ and θ shown in Fig. 9), which are set using the UIs to be described later.

[0041]

The first embodiment can generate a profile required to obtain a monochrome print image with a tincture based on user's intention, since it comprises of means for setting the gray chromaticity point and chromaticity point change rate.

[0042]

<UI>

Figs. 11 and 12 show examples of tincture adjustment value setting user interfaces (UIs) in the first embodiment. Fig. 11 shows an example of a UI used to set the gray chromaticity point. As shown in Fig. 11, this UI includes a text box 1101 used to set

an a* value of the CIELAB color space, a text box 1102 used to set a b* value, an OK button 1103, and a cancel button 1104. The a* and b* values of the gray chromaticity point corresponding to the point G shown in Fig. 8 are input to the text boxes 1101 and 1102. When the user selects the OK button 1103, the input chromaticity point is set, and the corresponding chromaticity line table and tincture conversion table are respectively stored in the chromaticity line table holding module 410 and tincture conversion table holding module 409. When the user selects the cancel button 1104, the setting values are canceled, and the chromaticity line table and tincture conversion table are not updated.

[0043]

Fig. 12 shows an example of a UI used to set the chromaticity point change rate. As shown in Fig. 12, this UI includes a text box 1201 used to set a chromaticity change rate of a highlight part, a text box 1202 used to set a chromaticity change rate of a shadow part, an OK button 1203, and a cancel button 1204. A change rate per unit lightness (L*) of the aforementioned distance signal l is inputted into each text box. Let H_in be the value to be inputted into the text box 1201, and S_in be the value to be inputted into the text box 1202. Then, Φ and θ shown in Fig. 9, and H_in and S_in respectively have the following

relationships:

[0044]

$\Phi = \tan^{-1}(S\_in)$

$\theta = \tan^{-1}(H\_in)$

[0045]

When the user selects the OK button 1203, Φ and θ corresponding to the input values are set on the basis of the above equations, and the corresponding tincture conversion table is stored in the tincture conversion table holding module 409. On the other hand, when the user selects the cancel button 1204, setting values are canceled, and the tincture conversion table is not updated.

[0046]

<Image Processing Sequence>

Fig. 13 is a flow chart showing the profile generation sequence in the first embodiment. This profile generation process is executed in the following sequence.

[0047]

In step S1301, an output profile is set. In this output profile setting process, the output profile of the image output apparatus is acquired, and L*, a*, and b* color signals of white and black print colors, which depend on that image output apparatus and an image recording medium (print paper) are acquired. Furthermore, corresponding grayscale characteristics

are stored in the aforementioned grayscale characteristic holding module 408 on the basis of the acquired L values of the white and black print colors. In step S1302, tincture adjustment values are set. In this tincture adjustment value setting process, a corresponding tincture conversion table and chromaticity line table are respectively stored in the aforementioned tincture conversion table holding module 409 and chromaticity line table holding module 410 on the basis of the image output apparatus and image recording medium (print paper or the like), and the gray chromaticity point and chromaticity point change rate set by the aforementioned tincture adjustment value setting module 407.

[0048]

In step S1303, the aforementioned color signal generation module 401 generates a discrete monochrome signal GL which forms a 3D LUT to be stored in a profile. In step S1304, the aforementioned grayscale characteristic conversion module 402 converts the monochrome signal GL into a lightness value L*. In step S1305, the aforementioned tincture conversion A module 403 converts the lightness value L* into a distance function l. In step S1306, the aforementioned tincture conversion B module 404 converts the distance function l into a chromaticity coordinate signal (a*, b*) on the CIELAB color space.

[0049]

It is checked in step S1307 if the processes of all monochrome signals which form the 3D LUT of the profile are complete. If signals to be processed still remain, the flow returns to step S1303 to repeat the aforementioned processes. On the other hand, if it is determined in step S1307 that the processes of all signals are complete, the flow advances to step S1308, the aforementioned format module 405 forms a 3D LUT on the basis of the chromaticity coordinate signals (a*, b*) obtained in step S1306, and lightness values L* obtained in step S1304 generates a profile.

[0050]

As described above, according to the first embodiment, a profile used to print a monochrome image to have a desired tincture and to be free from any tincture change in a print process using the color management system (hereinafter referred to as a CMS) can be easily generated. More specifically, this embodiment comprises the means for setting the gray chromaticity point and chromaticity point change rate, and a profile is generated by determining a gray line on the basis of setting values. Using this profile, a monochrome print image with a tincture based on user's intention can be obtained.

[0051]

[Second Embodiment]

The second embodiment of the present invention will be described in detail hereinafter with reference to the accompanying drawings.

[0052]

An image processing apparatus of the second embodiment converts monochrome image data into color image data which can be printed with a desired tincture without any color deviation upon printing the monochrome image by a designated image output apparatus. Note that the basic arrangement of the image processing apparatus in the second embodiment is the same as that of the first embodiment explained using Fig. 3, and a description thereof will be omitted.

[0053]

<Functional Arrangement>

Fig. 14 is a block diagram showing the functional arrangement of the image processing apparatus in the second embodiment. As shown in Fig. 14, the apparatus comprises, as the functional arrangement, a grayscale characteristic conversion module 1401, tincture conversion A module 1402, tincture conversion B module 1403, output profile conversion module 1404, tincture adjustment value setting module 1405, profile acquisition module 1406, grayscale characteristic holding module 1407, tincture conversion table holding module 1408, chromaticity line table holding module

1409, and output profile holding module 1410.

[0054]

In this arrangement, monochrome signals GL that form an input monochrome image are converted into R, G, and B color signals, which are required to print the input monochrome image with a desired tincture without any color deviation upon printing the monochrome image by a designated image output apparatus, by the grayscale characteristic conversion module 1401, tincture conversion A module 1402, tincture conversion B module 1403, and output profile conversion module 1404. Note that the aforementioned functional modules -- except for the output profile conversion module 1404, profile acquisition module 1406, and output profile holding module 1410 -- have the same functions as those which have the same names in the first embodiment explained using Fig. 4, the description thereof will be omitted.

[0055]

The output profile conversion module 1404 converts input L*, a*, and b* color signals into R, G, and B color signals depending on the designated image output apparatus on the basis of an output profile stored in the output profile holding module 1410. Note that the inputted L*, a*, and b* color signals are adjusted to have a desired tincture, and to obscure tincture changes, as has been explained in the first

embodiment. For this reason, the image output apparatus can print the image data formed by the R, G, and B color signals as an image which has a desired tincture and inconspicuous tincture changes. Note that the output profile stored in the output profile holding module 1410 represents the color reproduction characteristics of the image output apparatus, and is acquired by the profile acquisition module 1406.

[0056]

Fig. 15 shows an example of the output profile stored in the output profile holding module 1410. This output profile is a correspondence table, that is, a so-called 3D look up table (LUT) of print colors (CIELAB values) in association with discrete R, G, and B color signals. The output profile conversion module 1404 searches this 3D LUT for data near the input L*, a*, and b* color signals, and calculates output R, G, and B color signals using a known interpolation method on the basis of the found data and the input signals.

[0057]

The profile acquisition module 1406 acquires an output profile of the designated image output apparatus. This output profile is obtained by printing a color patch image of discrete R, G, and B color signals, which form the 3D LUT by the image output apparatus, and measuring the printed color patch image.

[0058]

Fig. 16 shows an example of the color patch image in the second embodiment. The color patch image includes color patches of color signals, e.g., {R, G, B} = {0, 0, 0}, {0, 0, 16},..., {0, 0, 255}, {0, 16, 0}, {0, 16, 16},..., {255, 255, 255}. The acquired profile is stored in the output profile holding module 1410, and L*, a*, and b* color signals (colorimetric values of {R, G, B} = {255, 255, 255} and {0, 0, 0}) of white and black print colors are used in the grayscale characteristic holding module 1407 and tincture adjustment value setting module 1405.

[0059]

<Image Processing Sequence>

Fig. 17 is a flow chart showing the image processing sequence in the second embodiment. This image process is done in the following sequence.

[0060]

In step S1701, an initial setting process is made. In the initial setting process, a corresponding output profile is stored in the aforementioned output profile holding module 1410 in accordance with the designated image output apparatus and an image recording medium (print paper or the like). Also, an input monochrome image is set. In step S1702, tincture adjustment values are set. In this tincture adjustment value setting process, a corresponding tincture conversion table and chromaticity line table are

respectively stored in the aforementioned tincture conversion table holding module 1408 and chromaticity line table holding module 1409 on the basis of the image output apparatus and image recording medium (print paper, etc), and the gray chromaticity point and chromaticity point change rate set by the aforementioned tincture adjustment value setting module 1405.

[0061]

In step S1703, the aforementioned grayscale characteristic conversion module 1401 converts a monochrome signal GL which forms the input monochrome image into a lightness value L*. In step S1704, the aforementioned tincture conversion A module 1402 converts the lightness value L* into a distance function l. In step S1705, the aforementioned tincture conversion B module 1403 converts the distance function l into a chromaticity coordinate signal (a*, b*) on the CIELAB color space. In step S1706, the aforementioned output profile conversion module 1404 calculates R, G, and B color signals depending on the image output apparatus on the basis of that chromaticity coordinate signal (a*, b*) and the lightness value L* obtained in step S1703.

[0062]

It is checked in step S1707 if the processes of all monochrome signals which form the input monochrome

image are complete. If signals to be processed still remain, the flow returns to step S1703 to repeat the aforementioned processes. On the other hand, if the processes of all signals are complete, this image process ends.

[0063]

As described above, according to the second embodiment, monochrome image data can be converted into color image data which can be printed to have a desired tincture without any color deviation upon printing that monochrome image data by the image output apparatus.

[0064]

[Modification of First and Second Embodiments]

In the first and second embodiments mentioned above, the tincture conversion A module (403 in Fig. 4, 1402 in Fig. 14) converts the lightness value L* converted by the grayscale characteristic conversion module (402 in Fig. 4, 1401 in Fig. 14) into a distance signal l on the gray line. Alternatively, the tincture conversion A module may convert a monochrome signal GL into a distance signal l without temporarily converting it into lightness L*.

[0065]

Fig. 18 is a block diagram partially showing the functional arrangement of the image processing apparatus in a modification of the first and second embodiments. Note that the functional modules other

than a grayscale characteristic conversion module 1801, tincture conversion A module 1802, and tincture conversion B module 1803 are not shown in Fig. 18, and are the same as those in the first and second embodiments.

[0066]

The tincture conversion A module 1802 in this modification converts a monochrome signal GL which forms an input monochrome image into a distance signal 1. This conversion process converts the monochrome signal on the basis of a table as a correspondence table of distance signals 1 in association with discrete monochrome signals GL, in the same manner as in the first and second embodiments.

[0067]

[Third Embodiment]

The third embodiment of the present invention will be described in detail below with reference to the accompanying drawings.

[0068]

An image processing apparatus of the third embodiment converts color signals that form an input monochrome image into those for a connected image output apparatus, and converts them into color signals, which allow the image output apparatus to print a monochrome image with a desired tincture without any color deviation.

[0069]

<Arrangement with Peripheral Devices>

Fig. 19 is a block diagram showing the arrangement of an image processing apparatus in the third embodiment and its peripheral devices. As shown in Fig. 19, an image processing apparatus 1900 comprises an image input unit 1910, image processing unit 1920, and image output unit 1930. In this arrangement, monochrome image data read from an image recording medium 1901 is input via the image input unit 1910. The image processing unit 1920 converts the input monochrome image data into color signals for an image output apparatus 1902. The image output unit 1930 outputs the converted color signals to the image output apparatus 1902. The image output apparatus 1902 typically comprises a color printer which forms an image on a sheet surface by four, i.e., C, M, Y, and K inks or toners.

[0070]

<Basic Arrangement>

Fig. 20 is a block diagram showing the basic arrangement of the image processing apparatus 1900 in the third embodiment. Referring to Fig. 20, reference numeral 2001 denotes a CPU, which controls the overall apparatus using programs and data stored in a RAM and ROM (to be described below), and also executes image processes (to be described later). Reference numeral

2002 denotes a RAM which comprises an area for temporarily storing programs and data loaded from an external storage device or recording medium drive, and various data whose processes are underway, and also a work area used when the CPU 2001 executes respective processes. Reference numeral 2003 denotes a ROM which stores programs and control data, required to control the overall apparatus.

[0071]

Reference numeral 2004 denotes an operation unit, which comprises a keyboard and a pointing device such as a mouse or the like, and can input color characteristic parameters of the image output apparatus 1902 and an image recording medium (print paper or the like) and a gray tincture adjustment instruction (to be described later) to this apparatus. Reference numeral 2005 denotes a display unit which comprises of, inter alia, a CRT, and liquid crystal display, and displays various adjustment user interfaces (UIs; to be described later), images and text. Reference numeral 2006 denotes an interface (I/F) which connects the image output apparatus 1902 and is used to output data to the image output apparatus 1902. Reference numeral 2007 denotes an external storage device which saves an operating system (OS), and an image processing program 2008 and parameters 2009 required to implement various image processes. Typically, the image processing

program 2008 includes a control program of the image output apparatus 1902. Reference numeral 2010 denotes a recording medium drive, which reads various data including image data from the image recording medium 1901, and outputs them to the external storage device 2007 and RAM 2002. Reference numeral 2011 denotes a bus which interconnects the aforementioned units.

[0072]

<Functional Arrangement>

Fig. 21 is a block diagram showing the functional arrangement of the image processing unit 1920 shown in Fig. 19. As shown in Fig. 21, the image processing unit 1920 comprises a grayscale characteristic conversion module 2101, tincture conversion A module 2102, tincture conversion B module 2103, output profile conversion module 2104, color separation conversion module 2105, and tincture adjustment value setting module 2106. The image processing unit 1920 converts monochrome signals GL which form an input monochrome image into input C, M, Y, and K color signals for the image output apparatus 1902.

[0073]

The grayscale characteristic conversion module 2101 converts monochrome signals GL which form an input monochrome image into lightness values L* of a print image, obtained when the monochrome signals GL are outputted by the image output apparatus 1902, on the

basis of grayscale characteristics stored in a grayscale characteristic holding module 2107. Note that the grayscale characteristics stored in the grayscale characteristic holding module 2107 are the same as those shown in Fig. 5 explained in the first embodiment, and the relationship between the monochrome signals GL and lightness values L* is also the same as that shown in Fig. 6. Hence, a description thereof will be omitted.

[0074]

The tincture conversion A module 2102 converts each lightness value L* as an input signal into a distance signal l on the chromaticity space on the basis of a tincture conversion table stored in a tincture conversion table holding module 2108. Note that the tincture conversion table stored in the tincture conversion table holding module 2108 is the same as that shown in Fig. 7 described in the first embodiment. Also, the distance signal l and the chromaticity point path (gray line), (are) for example the chromaticity point path projected onto the a*b* chromaticity plane on the CIELAB color space, and the relationship between lightness values L* and distance signals l, which form the tincture conversion table, are the same as those shown in Figs. 8 and 9, and a description thereof will be omitted.

[0075]

The tincture conversion B module 2103 converts each distance signal l as an input signal into a chromaticity coordinate signal (a*, b*) on the CIELAB color space on the basis of a chromaticity line table stored in a chromaticity line table holding module 2109. Note that the chromaticity line table stored in the chromaticity line table holding module 2109 is the same as that shown in Fig. 10 explained in the first embodiment, and a description thereof will be omitted.

[0076]

The output profile conversion module 2104 converts input L*, a*, and b* signals into R, G, and B color signals depending on the image output apparatus 1902 on the basis of an output profile stored in an output profile holding module 2110.

[0077]

Fig. 22 shows an example of the output profile stored in the output profile holding module 2110. This output profile is a correspondence table, that is, a so-called "3D lookup table (LUT)" of print colors (CIELAB values) in association with discrete R, G, and B color signals, and pertains to the color reproduction characteristics of the image output apparatus 1902 and image recording medium (print paper or the like). The output profile conversion module 2104 searches this 3D LUT for data near the input L*, a*, and b* color signals, and calculates output R, G, and B color

signals using a known interpolation method on the basis of the found data and the input signals.

[0078]

The color separation conversion module 2105 converts the input R, G, and B color signals into C, M, Y, and K color signals for the image output apparatus 1902 on the basis of a color separation LUT stored in a color separation LUT holding module 2111.

[0079]

Fig. 23 shows an example of the color separation LUT stored in the color separation LUT holding module 2111. This color separation LUT is a correspondence table of C, M, Y, and K signals in association with discrete R, G, and B color signals, and pertains to the color reproduction characteristics of the image output apparatus 1902 and image recording medium (print paper or the like). The color separation conversion module 2105 converts input R, G, and B color signals into output C, M, Y, and K color signals by a known method using this color separation LUT.

[0080]

The tincture adjustment value setting module 2106 sets a gray chromaticity point (point G shown in Fig. 8) and chromaticity point change rate (values associates with Φ and θ shown in Fig. 9) using tincture adjustment value setting user interfaces (UIs), and sets the tincture conversion table to be

stored in the tincture conversion table holding module 2108 and the chromaticity line table to be stored in the chromaticity line table holding module 2109. Note that the tincture adjustment value setting user interfaces (UIs) that are the same as those shown in Figs. 11 and 12 described in the first embodiment, and a description thereof will be omitted.

[0081]

In this way, in the third embodiment as well, since the gray chromaticity point and chromaticity point change rate are set, a monochrome print image with a tincture based on user's intention can be obtained.

[0082]

<Image Processing Sequence>

Fig. 24 is a flow chart showing the image processing sequence according to the third embodiment. This image process is executed in the following sequence.

[0083]

In step S2401, an initial setting process is made. In the initial setting process, a corresponding output profile and color separation LUT are stored in the output profile holding module 2110 and color separation LUT holding module 2111 in accordance with the image output apparatus 1902 and an image recording medium (print paper or the like). Also, defaulted or

designated grayscale characteristics are stored in the grayscale characteristic holding module 2107. Furthermore, an input monochrome image is set.

[0084]

In step S2402, tincture adjustment values are set. In this tincture adjustment value setting process, a corresponding tincture conversion table and chromaticity line table are respectively stored in the aforementioned tincture conversion table holding module 2108 and chromaticity line table holding module 2109, on the basis of the image output apparatus 1902 and image recording medium (print paper or the like), and the gray chromaticity point and chromaticity point change rate set by the aforementioned tincture adjustment value setting module 2106.

[0085]

In step S2403, the aforementioned grayscale characteristic conversion module 2101 converts a monochrome signal GL which forms the input monochrome image into a lightness value L*. In step S2404, the aforementioned tincture conversion A module 2102 converts the lightness value L* into a distance function l. In step S2405, the aforementioned tincture conversion B module 2103 converts the distance function l into a chromaticity coordinate signal (a*, b*) on the CIELAB color space.

[0086]

In step S2406, the output profile conversion module 2104 calculates R, G, and B color signals depending on the image output apparatus 1902 on the basis of the chromaticity coordinate signal (a*, b*) obtained in step S2405 and the lightness value L* obtained in step S2403. In step S2407, the color separation conversion module 2105 converts the R, G, and B color signals obtained in step S2406 into output C, M, Y, and K color signals for the image output apparatus 1902, and outputs the converted signals. It is checked in step S2408 if the processes of all monochrome signals which form the input monochrome image are complete. If signals to be processed still remain, the flow returns to step S2403 to repeat the aforementioned processes.

[0087]

As described above, according to the third embodiment, the tincture of a monochrome image can be easily adjusted without any tincture changes. More specifically, this embodiment has means for setting a gray chromaticity point and chromaticity point change rate, and sets a gray line on the basis of the setting values. As a result, a monochrome print image with a tincture based on user's intention can be obtained.

[0088]

[Modification of UI]

A modification of the tincture adjustment value

setting user interfaces (UIs) in the first to third embodiments will be described below.

[0089]

Since the tincture adjustment value setting user interfaces (UIs) explained using Figs. 11 and 12 have high degrees of freedom, if they are misused, a desired image cannot be obtained, and an unacceptable result may be obtained in the worst case. Hence, a modification of these UIs, which can prevent excessive processes against user's will in adjustment of the tincture of a monochrome image, will be explained. Note that the basic arrangement, functional arrangement, and image processing sequence are the same as those in the third embodiment, and a description thereof will be omitted.

[0090]

Fig. 25 shows an example of a UI used to set a gray chromaticity point in the modification. As shown in Fig. 25, the UI includes eight tincture setting buttons 2501 to 2508, gray setting map 2509, OK button 2510, and cancel button 2511. Note that the gray setting map 2509 is a grid image corresponding to the a*b* plane of the CIELAB color space, and grid A at a position corresponding to a* and b* of the current gray chromaticity point is indicated by black. The horizontal direction corresponds to the a* axis, and the vertical direction corresponds to the b* axis.

When the black grid moves rightward, a tinge of red is enhanced; when it moves upward, a tinge of yellow is enhanced; when it moves leftward, a tinge of green is enhanced; and when it moves downward, a tinge of blue is enhanced.

[0091]

When the tincture setting button 2501 is selected, the black grid position moves in the right direction to enhance a tinge of red. Likewise, the black grid position moves in the upper right direction upon selection of the tincture setting button 2502; in the upper direction upon selection of the tincture setting button 2503; in the upper left direction upon selection of the tincture setting button 2504; in the left direction upon selection of the tincture setting button 2505; in the lower left direction upon selection of the tincture setting button 2506; in the lower direction upon selection of the tincture setting button 2507; and in the lower right direction upon selection of the tincture setting button 2508. The gray chromaticity point (point G shown in Fig. 8) is then set in a color corresponding to the moved position. By limiting a setting range, an excessive tincture can be prevented from being set.

[0092]

On the gray setting map 2509, a region outside the setting range is indicated using another color to

be distinguished from the setting range. When the black grid position is to be moved outside the setting range by the tincture setting button, an alarm sound is generated to inhibit such movement. When the user selects the OK button 2510, the input chromaticity point is set, and the corresponding chromaticity line table and tincture conversion table are respectively stored in the chromaticity line table holding module 2109 and tincture conversion table holding module 2108. When the user selects the cancel button 2511, the setting value is canceled, and the chromaticity line table and tincture conversion table are not updated. This setting range is determined in accordance with the subjective evaluation results of output images corresponding to respective setting values. For example, when images are output while changing the setting values in an appropriate step, and undergo subjective evaluation, the range of setting values corresponding to images "accepted" by more than half evaluators is determined as the setting range.

[0093]

Fig. 26 shows an example of a UI used to set a chromaticity point change rate in the modification. As shown in Fig. 26, the UI includes a slide bar 2601 used to set a chromaticity change rate of a highlight part, a slide bar 2602 used to set a chromaticity change rate of a shadow part, an OK button 2603, and a cancel

button 2604. By moving the respective slide bars, the values Φ and θ shown in Fig. 9 are increased/decreased, thus setting the chromaticity change rate. For example, when the slide bar 2601 used to set the chromaticity change rate of a highlight part is moved to the right, Φ increases; when it is moved to the left, Φ decreases. At this time, by limiting a setting range, an excessive tincture can be prevented from being set. In the example shown in Fig. 26, the setting range of the slide bar 2601 used to set the chromaticity change rate of a highlight part is limited to a range from B to C. Likewise, the setting range of the slide bar 2602 used to set the chromaticity change rate of a shadow part is limited to a range from D to E.

[0094]

Upon selection of the OK button 2603, Φ and θ are set on the basis of the slide bar positions, and a corresponding tincture conversion table is stored in the tincture conversion table holding module 2108. Upon selection of the cancel button 2604, setting values are canceled, and the tincture conversion table is not updated. This setting range is determined according to the subjective evaluation results of output images corresponding to respective setting values.

[0095]

According to the arrangement of the modification, since the setting ranges of the gray chromaticity point and chromaticity point change rate are limited upon setting the tincture of a monochrome image, an excessive process against user's will can be prevented.

[0096]

[Modification of Third Embodiment]

<Default Value and Setting Range>

Default values and setting ranges of the aforementioned gray chromaticity point and chromaticity point change rate may be set. The default values and setting ranges may be held in correspondence with respective image recording media (print paper or the like). In this case, the tincture adjustment value setting module 2106 in Fig. 21 is used to store these default values and setting ranges.

[0097]

<Save Setting Value>

The setting values of the gray chromaticity point and chromaticity point change rate may be saved. In such cases, the tincture adjustment value setting module 2106 in Fig. 21 is used to store the setting values. Also, the setting values may be registered in a list, and by selecting a registered setup from the list, setting values corresponding to the selected setup may be re-used.

[0098]

<Tincture Conversion A Module>

The aforementioned tincture conversion A module 2102 converts a lightness value L* into a distance signal l on the gray line. Alternatively, the tincture conversion A module may convert a monochrome signal GL into a distance signal l without temporarily converting it into lightness L*.

[0099]

Fig. 27 is a block diagram showing the functional arrangement of an image processing unit in the modification of the third embodiment. As shown in Fig. 27, the image processing unit of this modification comprises of grayscale characteristic conversion module 2701, tincture conversion A module 2702, tincture conversion B module 2703, output profile conversion module 2704, color separation conversion module 2705, and tincture adjustment value setting module 2706. This image processing unit converts monochrome signals GL which form an input monochrome image into input C, M, Y, and K color signals for the image output apparatus 1902.

[0100]

The tincture adjustment setting module 2706 of this modification sets a change rate of a distance signal l in association with a monochrome signal GL, that is, a chromaticity point change rate, using the aforementioned UI, and stores a tincture conversion

table corresponding to that change rate in a tincture conversion table holding unit 2708. The tincture conversion A module 2702 converts each monochrome signal GL which forms an input monochrome image into a distance signal 1 on the basis of the tincture conversion table stored in the tincture conversion table holding module 2708. Other functional modules have the have the same functions as those which have the same names in the third embodiment.

[0101]

According to the modification of the third embodiment, tincture adjustment can be done independently of grayscale conversion.

[0102]

As described above, according to the third embodiment and its modification, the tincture of a print color can be easily adjusted to be free from any tincture deviation and to obscure tincture changes.

[0103]

Note that the present invention may be applied to either a system constituted by a plurality of devices (e.g., a host computer, interface device, reader, printer, and the like), or an apparatus consisting of a single equipment (e.g., a copying machine, facsimile apparatus, or the like).

[0104]

The objects of the present invention are also

achieved by supplying a recording medium, which records a program code of a software program that can implement the functions of the above-mentioned embodiments to the system or apparatus, and reading out and executing the program code stored in the recording medium by a computer (or a CPU or MPU) of the system or apparatus.

[0105]

In this case, the program code itself reads out from the recording medium implements the functions of the above-mentioned embodiments, and the recording medium which stores the program code constitutes the present invention.

[0106]

A number of various recording mediums for supplying the program code may be used: for example, a floppy® disk, hard disk, optical disk, magneto-optical disk, CD-ROM, CD-R, magnetic tape, nonvolatile memory card, and ROM.

[0107]

The functions of the above-mentioned embodiments may be implemented, not only by executing the readout program code by the computer, but also by some or all of actual processing operations executed by an OS (operating system) running on the computer on the basis of an instruction of the program code.

[0108]

Furthermore, the functions of the above-mentioned

embodiments may be implemented by some or all of the actual processing operations executed by a CPU, or the like, arranged in a function extension board or a function extension unit, which is inserted in or connected to the computer after the program code read out from the recording medium is written in a memory of the extension board or unit.

[0109]

[Aspects]

Aspects of the present invention will be described hereinafter.

[0110]

[Aspect 1] A color conversion method of an image processing apparatus for converting an input monochrome signal into a color signal on a predetermined color space A, comprising:

a setting step of setting a tincture adjustment value used to adjust the monochrome signal to a desired tincture of a user;

an acquisition step of acquiring color reproduction characteristics which depend on an image output apparatus and a recording medium;

a first conversion step of converting the input monochrome signal into a first color signal using the color reproduction characteristics acquired in the acquisition step;

a second conversion step of converting the input monochrome signal or the color signal converted in the first conversion step into a second color signal using the tincture adjustment value set in the setting step and the color reproduction characteristics acquired in the acquisition step;

a third conversion step of converting the color signal converted in the second conversion step into a third color signal; and

an output step of forming and outputting a color signal on the color space A on the basis of the color signal converted in the third conversion step and the color signal converted in the first conversion step.

[0111]

[Aspect 2] The method according to aspect 1, wherein the color signal on the color space A is expressed by a lightness value, and a chromaticity point which pertains to hue and saturation attributes.

[0112]

[Aspect 3] The method according to aspect 2, wherein the setting step includes a step of setting, as the tincture adjustment value, a chromaticity point on the color space A corresponding to a predetermined monochrome signal and a change rate of a chromaticity point on the color space A associated with a monochrome signal.

[0113]

[Aspect 4] The method according to aspect 3, wherein the acquisition step includes a step of acquiring, as the color reproduction characteristics, color signals on the color space A, which correspond to monochrome signals indicating white and black.

[0114]

[Aspect 5] The method according to aspect 3 or 4, wherein in the setting step, the predetermined monochrome signal is a monochrome signal corresponding to middle lightness, and the change rate of the chromaticity point is a change rate of chromaticity points associated with monochrome signals of highlight and shadow parts.

[0115]

[Aspect 6] The method according to aspect 4 or 5, wherein in the setting step, the change rate of the chromaticity point is, on the color space A, a change rate of distance on a line segment L in association with a monochrome signal, when the line segment L represents a line segment which connects the chromaticity point, which corresponds to the monochrome signal indicating white acquired in the acquisition step, the chromaticity point set in the setting step, and the chromaticity point, which corresponds to the monochrome signal indicating black acquired in the acquisition step.

[0116]

[Aspect 7] The method according to aspect 6, wherein the first conversion step includes a step of converting the input monochrome signal into a color signal indicating a lightness value on the color space A,

the second conversion step includes a step of converting the input monochrome signal or the color signal converted in the first conversion step into a color signal indicating a distance on the line segment L,

the third conversion step includes a step of converting the color signal converted in the second conversion step into a color signal indicating a chromaticity point on the color space A, and

the output step includes a step of forming and outputting the color signal on the color space A, on the basis of the color signal which is converted in the first conversion step and indicates the lightness value on the color space A, and the color signal which is converted in the third conversion step and indicates the chromaticity point on the color space A.

[0117]

[Aspect 8] The method according to aspect 7, wherein the color space is a CIE/L*a*b* color space on which a lightness value is represented by L* and a chromaticity point is represented by a* and b*.

[0118]

[Aspect 9] The method according to aspect 7 or 8,

wherein the setting step includes a step of setting the chromaticity point and the chromaticity point change rate within predetermined ranges.

[0119]

[Aspect 10] A program for causing a computer to execute a color conversion method of an image processing apparatus recited in any one of aspects 7 to 9.

[0120]

[Aspect 11] A profile generation apparatus for generating a profile which stores a relationship between monochrome signals and color signals on a predetermined color space A, comprising:

setting means for setting a tincture adjustment value used to adjust monochrome signals to a desired tincture of a user;

acquisition means for acquiring color reproduction characteristics which depend on an image output apparatus and a recording medium;

generation means for generating discrete monochrome signals;

first conversion means for converting the monochrome signals generated by said generation means into first color signals using the color reproduction characteristics acquired by said acquisition means;

second conversion means for converting the monochrome signals generated by said generation means

or the color signals converted by said first conversion means into second color signals using the tincture adjustment value set by said setting means and the color signals acquired by said acquisition means;

third conversion means for converting the color signals converted by said second conversion means into third color signals; and

output means for generating and outputting a profile on the basis of the color signals converted by said third conversion means and the color signals converted by said first conversion means,

wherein the color signal on the color space A is expressed by a lightness value, and a chromaticity point which pertains to hue and saturation attributes,

said setting means sets, as the tincture adjustment value, a chromaticity point on the color space A corresponding to a predetermined monochrome signal and a change rate of a chromaticity point on the color space A associated with monochrome signals,

said acquisition means acquires, as the color reproduction characteristics, color signals on the color space A, which correspond to monochrome signals indicating white and black,

in said setting means, the predetermined monochrome signal is a monochrome signal corresponding to middle lightness,

the change rate of the chromaticity point is a

change rate of chromaticity points associated with monochrome signals of highlight and shadow parts,

in said setting means, the change rate of the chromaticity point is, on the color space A, a change rate of distance on a line segment L in association with a monochrome signal, when the line segment L represents a line segment which connects the chromaticity point, which corresponds to the monochrome signal indicating white acquired by said acquisition means, the chromaticity point set by said setting means, and the chromaticity point, which corresponds to the monochrome signal indicating black acquired by said acquisition means,

said first conversion means converts the monochrome signal generated by said generation means into a color signal indicating a lightness value on the color space A,

said second conversion means converts the monochrome signal generated by said generation means or the color signal converted by said first conversion means into a color signal indicating a distance on the line segment L,

said third conversion means converts the color signal converted by said second conversion means into a color signal indicating a chromaticity point on the color space A, and

said output means forms and outputs the color

signal on the color space A, by using the color signal which is converted by said first conversion means and indicates the lightness value on the color space A, and the color signal which is converted by said third conversion means and indicates the chromaticity point on the color space A.

[0121]

[Aspect 12] The apparatus according to aspect 11, wherein said setting means sets the chromaticity point and the chromaticity point change rate within predetermined ranges.

[0122]

[Aspect 13] A program for causing a computer to execute a profile generation method of a profile generation apparatus recited in aspect 11 or 12.

[0123]

[Aspect 14] An image conversion apparatus for converting input monochrome image data into color image data for an image output apparatus designated, comprising:

setting means for setting a tincture adjustment value used to adjust the monochrome image data to a desired tincture of a user;

acquisition means for acquiring color reproduction characteristics which depend on the image output apparatus and a recording medium;

first conversion means for converting monochrome signals which form the input monochrome image data into first color signals using the color reproduction characteristics acquired by said acquisition means;

second conversion means for converting monochrome signals which form the input monochrome image data or the color signals converted by said first conversion means into second color signals using the tincture adjustment value set by said setting means and the color signals acquired by said acquisition means;

third conversion means for converting the color signals converted by said second conversion means into third color signals; and

outputting means for generating and outputting the color image data for the image output apparatus on the basis of the color signals converted by said third conversion means and the color signals converted by said first conversion means using the color reproduction characteristics acquired by said acquisition means,

wherein the color signal on the color space A is expressed by a lightness value, and a chromaticity point which pertains to hue and saturation attributes,

said setting means sets, as the tincture adjustment value, a chromaticity point on the color space A corresponding to a predetermined monochrome signal and a change rate of a chromaticity point on the

color space A associated with monochrome signals,

said acquisition means acquires color signals on the color space A, which correspond to discrete color signals including color signals indicating white and black of the image output apparatus,

in said setting means, the predetermined monochrome signal is a monochrome signal corresponding to middle lightness,

the change rate of the chromaticity point is a change rate of chromaticity points associated with monochrome signals of highlight and shadow parts,

in said setting means, the change rate of the chromaticity point is, on the color space A, a change rate of distance on a line segment L in association with a monochrome signal, when the line segment L represents a line segment which connects the chromaticity point, which corresponds to the monochrome signal indicating white acquired by said acquisition means, the chromaticity point set by said setting means, and the chromaticity point, which corresponds to the monochrome signal indicating black acquired by said acquisition means,

said first conversion means converts the monochrome signals which form the input monochrome image data into color signals indicating a lightness value on the color space A,

said second conversion means converts the monochrome signals which form the input monochrome image data or the color signals converted by said first conversion means into color signals indicating a distance on the line segment L,

said third conversion means converts the color signals converted by said second conversion means into color signals indicating a chromaticity point on the color space A, and

said output means generates and outputs the color image data for the image output apparatus on the basis of the color signal which is converted by said first conversion means and indicates the lightness value on the color space A, and the color signal which is converted by said third conversion means and indicates the chromaticity point on the color space A, using the color reproduction characteristics acquired by said acquisition means.

[0124]

[Aspect 15] The apparatus according to aspect 14, wherein said setting means sets the chromaticity point and the chromaticity point change rate within predetermined ranges.

[0125]

[Aspect 16] A program for causing a computer to execute an image conversion method of an image conversion apparatus recited in aspect 14 or 15.

[0126]

[Aspect 17] An image processing apparatus for converting monochrome signals which form the input monochrome image data into color signals for a connected image output apparatus, comprising:

setting means for setting a tincture adjustment value used to adjust the monochrome image data to a desired tincture of a user;

acquisition means for acquiring color reproduction characteristics which depend on the image output apparatus and a recording medium;

first conversion means for converting monochrome signals which form the input monochrome image data into first color signals using the color reproduction characteristics acquired by said acquisition means;

second conversion means for converting monochrome signals which form the input monochrome image data or the color signals converted by said first conversion means into second color signals using the tincture adjustment value set by said setting means and the color reproduction characteristics acquired by said acquisition means;

third conversion means for converting the color signals converted by said second conversion means into third color signals; and

outputting means for converting the color signals converted by said third conversion means and the color

signals converted by said first conversion means into the color image data for the image output apparatus using the color reproduction characteristics acquired by said acquisition means, and outputting the converted color signals,

wherein the color signal on the color space A is expressed by a lightness value, and a chromaticity point which pertains to hue and saturation attributes,

said setting means sets, as the tincture adjustment value, a chromaticity point on the color space A corresponding to a predetermined monochrome signal and a change rate of a chromaticity point on the color space A associated with monochrome signals,

said acquisition means acquires color signals on the color space A, which correspond to discrete color signals including color signals indicating white and black of the image output apparatus,

in said setting means, the predetermined monochrome signal is a monochrome signal corresponding to middle lightness,

the change rate of the chromaticity point is a change rate of chromaticity points associated with monochrome signals of highlight and shadow parts,

in said setting means, the change rate of the chromaticity point is, on the color space A, a change rate of distance on a line segment L in association with a monochrome signal, when the line segment L

represents a line segment which connects the chromaticity point, which corresponds to the monochrome signal indicating white acquired by said acquisition means, the chromaticity point set by said setting means, and the chromaticity point, which corresponds to the monochrome signal indicating black acquired by said acquisition means,

said first conversion means converts the monochrome signals which form the input monochrome image data into color signals indicating a lightness value on the color space A,

said second conversion means converts the monochrome signals which form the input monochrome image data or the color signals converted by said first conversion means into color signals indicating a distance on the line segment L,

said third conversion means converts the color signals converted by said second conversion means into color signals indicating a chromaticity point on the color space A, and

said output means generates and outputs the color image data for the image output apparatus on the basis of the color signal which is converted by said first conversion means and indicates the lightness value on the color space A, and the color signal which is converted by said third conversion means and indicates the chromaticity point on the color space A, using the

color reproduction characteristics acquired by said acquisition means.

[0127]

[Aspect 18] The apparatus according to aspect 17, wherein said setting means sets the chromaticity point and the chromaticity point change rate within predetermined ranges.

[0128]

[Aspect 19] A program for causing a computer to execute an image conversion method of an image processing apparatus recited in aspect 17 or 18.

[0129]

[Aspect 20] A computer-readable recording medium in which the program recited in any one of aspects 10, 13, 16 and 19 is recorded.

[0130]

[Effect of the Invention]

As described above, according to the present invetion, a profile used to print a monochrome image with a tincture of user's choice without any color deviation may be generated.

[Brief Description of the Drawings]

[Fig. 1]

Fig. 1 is a view for explaining an overview of a color management system (CMS).

[Fig. 2]

Fig. 2 is a block diagram showing an example of

an image output system using a CMS.

[Fig. 3]

Fig. 3 is a block diagram showing the basic arrangement of an image processing apparatus in the first embodiment.

[Fig. 4]

Fig. 4 is a block diagram showing the functional arrangement of the image processing apparatus in the first embodiment.

[Fig. 5]

Fig. 5 shows an example of grayscale characteristics stored in a grayscale characteristic holding module 408.

[Fig. 6]

Fig. 6 shows an example of the relationship between a monochrome signal GL and lightness L*.

[Fig. 7]

Fig. 7 shows an example of a tincture conversion table stored in a tincture conversion table holding module 409.

[Fig. 8]

Fig. 8 illustrates a chromatic point path projected onto an a*b* chromaticity plane on the CIELAB color space.

[Fig. 9]

Fig. 9 shows an example of the relationship between lightness values L* and distance signals l,

which form the tincture conversion table shown in Fig. 7.

[Fig. 10]

Fig. 10 shows an example of a chromaticity line table stored in a chromaticity line table holding module 410.

[Fig. 11]

Fig. 11 shows an example of a UI used to set a gray chromaticity point.

[Fig. 12]

Fig. 12 shows an example of a UI used to a chromaticity point change rate.

[Fig. 13]

Fig. 13 is a flow chart showing the profile generation sequence in the first embodiment.

[Fig. 14]

Fig. 14 is a block diagram showing the functional arrangement of an image processing apparatus in the second embodiment.

[Fig. 15]

Fig. 15 shows an example of an output profile stored in an output profile holding module 1410.

[Fig. 16]

Fig. 16 shows an example of a color patch image in the second embodiment.

[Fig. 17]

Fig. 17 is a flow chart showing the image

processing sequence in the second embodiment.

[Fig. 18]

Fig. 18 is a block diagram partially showing the functional arrangement of the image processing apparatus in a modification of the first and second embodiments.

[Fig. 19]

Fig. 19 is a block diagram showing the arrangement of an image processing apparatus and its peripheral devices in the third embodiment.

[Fig. 20]

Fig. 20 is a block diagram showing the basic arrangement of an image processing apparatus 1900 in the third embodiment.

[Fig. 21]

Fig. 21 is a block diagram showing the functional arrangement of an image processing unit 1920 shown in Fig. 19.

[Fig. 22]

Fig. 22 shows an example of an output profile stored in an output profile holding module 2110.

[Fig. 23]

Fig. 23 shows an example of a color separation LUT stored in a color separation LUT holding module 2111.

[Fig. 24]

Fig. 24 is a flow chart showing the image

processing sequence in the third embodiment.

[Fig. 25]

Fig. 25 shows an example of a UI used to set a gray chromaticity point in a modification.

[Fig. 26]

Fig. 26 shows an example of a UI used to set a change rate of a chromaticity point in a modification.

[Fig. 27]

Fig. 27 is a block diagram showing the functional arrangement of an image processing unit in a modification of the third embodiment.

[Description of the Reference Numerals]

101 COLOR COPY

102 COLOR MONITOR

103 DIGITAL CAMERA

104 COLOR PRINTER

201 INPUT PROFILE CONVERSION UNIT

202 COLOR MAPPING UNIT

203 OUTPUT PROFILE CONVERSION UNIT

204 COLOR SEPARATION CONVERSION UNIT

205 INPUT PROFILE STORAGE UNIT

206 OUTPUT PROFILE STORAGE UNIT

207 COLOR SEPARATION LUT STORAGE UNIT

301 CPU

302 RAM

303 ROM

304 OPERATION UNIT

305 DISPLAY UNIT

306 EXTERNAL STORAGE DEVICE

307 IMAGE PROCESSING PROGRAM

308 PARAMETERS

309 RECORDING MEDIUM DRIVE

310 BUS

401 COLOR SIGNAL GENERATION MODULE

402 GRAYSCALE CHARACTERISTIC CONVERSION MODULE

403 TINCTURE CONVERSION A MODULE

404 TINCTURE CONVERSION B MODULE

405 FORMAT MODULE

406 PROFILE ACQUISITION MODULE

407 TINCTURE ADJUSTMENT VALUE SETTING MODULE

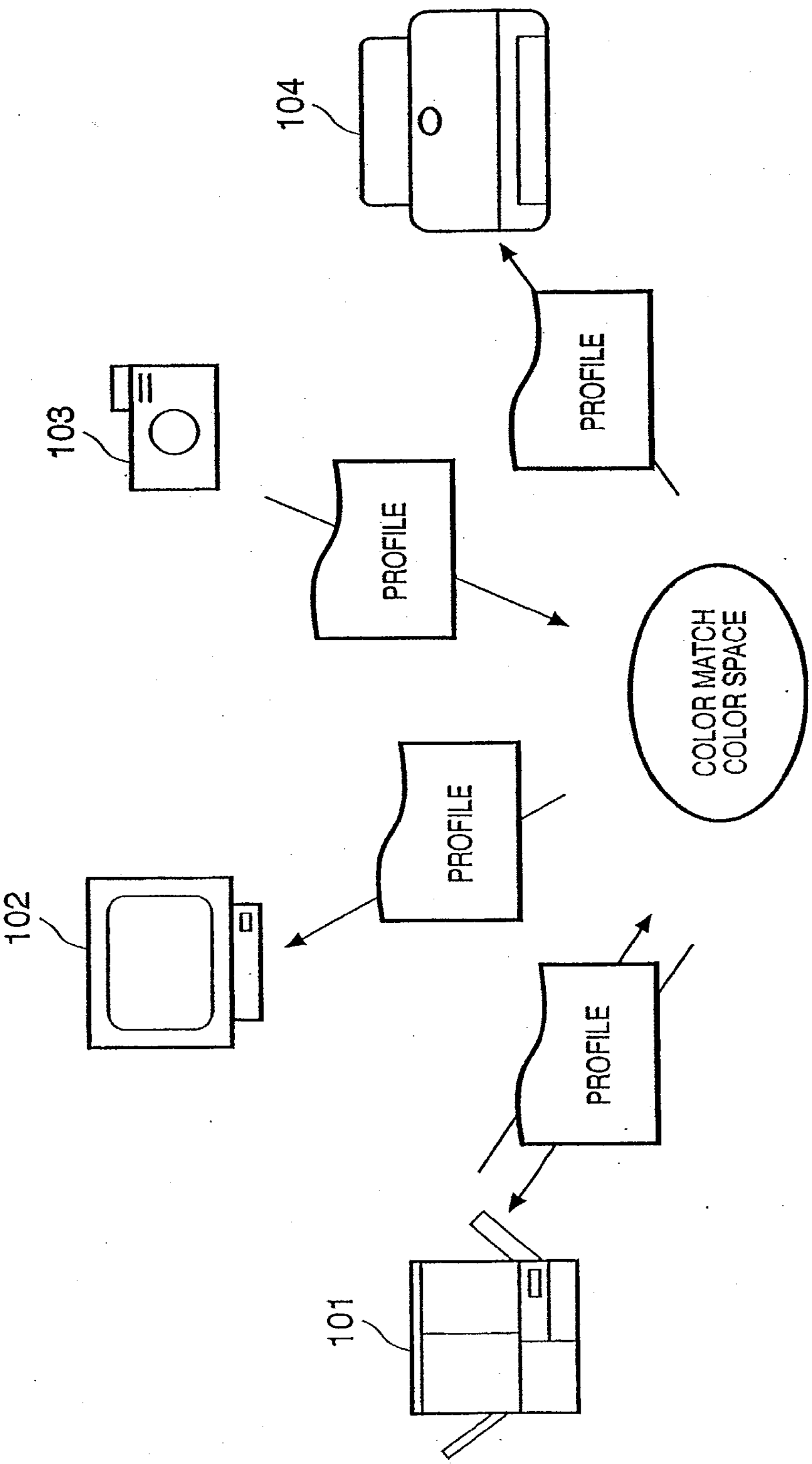
408 GRAYSCALE CHARACTERISTIC HOLDING MODULE

409 TINCTURE CONVERSION TABLE HOLDING MODULE

410 CHROMATICITY LINE TABLE HOLDING MODULE

[TYPE OF DOCUMENT] DRAWINGS

FIG. 1



F I G. 2

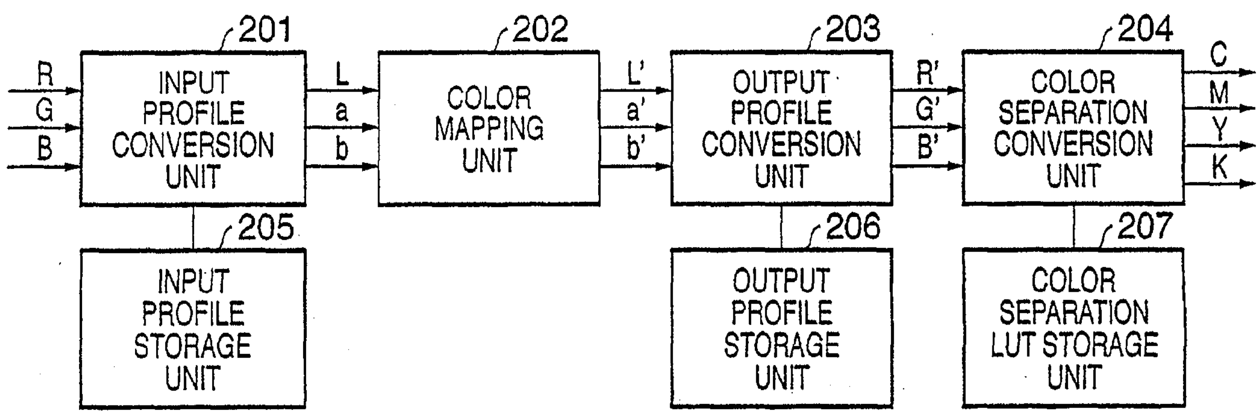
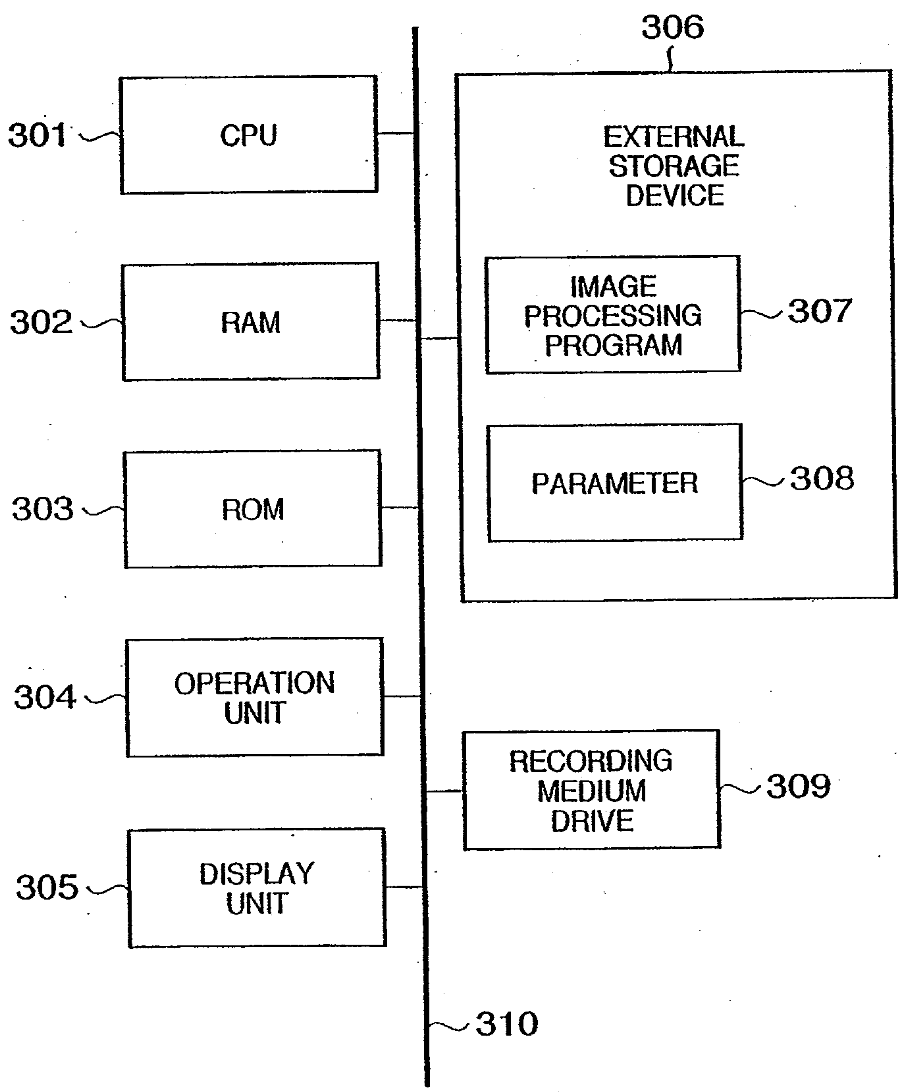

201
202
203
204
R
G
B
INPUT PROFILE CONVERSION UNIT
L
a
b
COLOR MAPPING UNIT
L'
a'
b'
OUTPUT PROFILE CONVERSION UNIT
R'
G'
B'
COLOR SEPARATION CONVERSION UNIT
C
M
Y
K
205
206
207
INPUT PROFILE STORAGE UNIT
OUTPUT PROFILE STORAGE UNIT
COLOR SEPARATION LUT STORAGE UNIT

FIG. 3



306
301
CPU
EXTERNAL STORAGE DEVICE
302
RAM
IMAGE PROCESSING PROGRAM
307
303
ROM
PARAMETER
308
304
OPERATION UNIT
RECORDING MEDIUM DRIVE
309
305
DISPLAY UNIT
310

FIG. 4

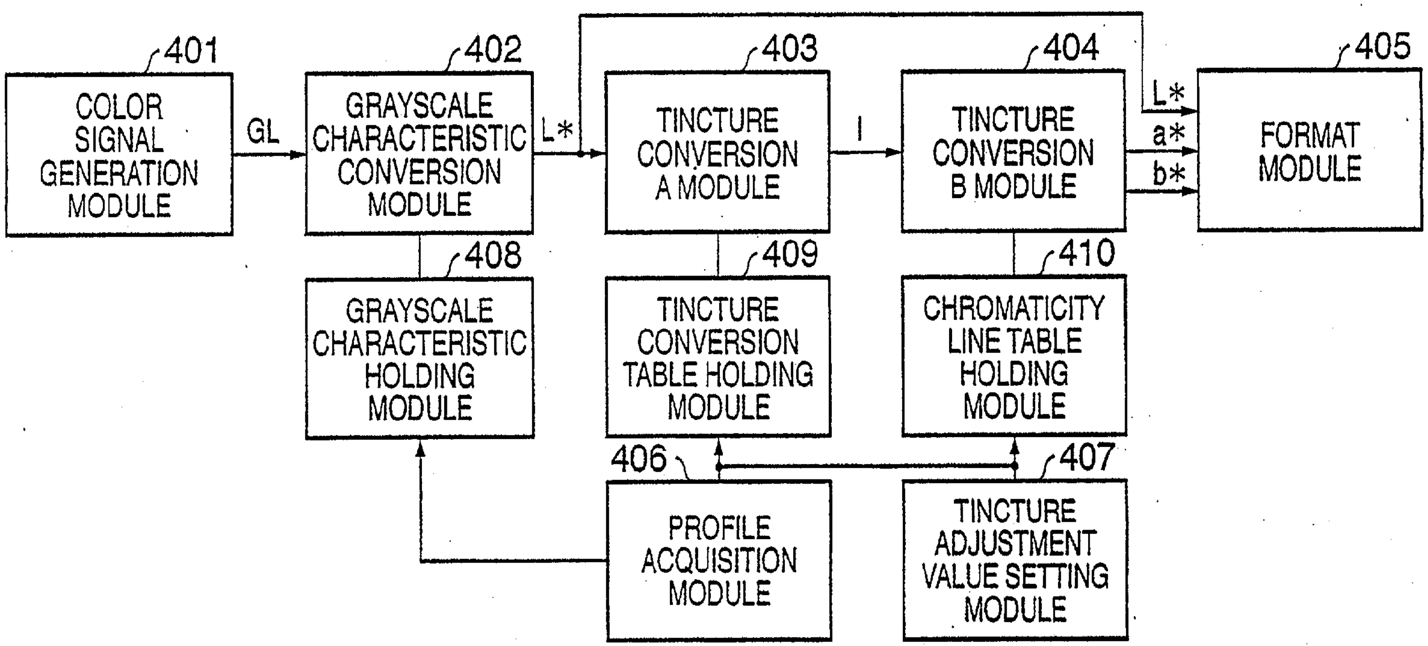

401
COLOR SIGNAL GENERATION MODULE
GL
402
GRAYSCALE CHARACTERISTIC CONVERSION MODULE
L*
403
TINCTURE CONVERSION A MODULE
I
404
TINCTURE CONVERSION B MODULE
L*
a*
b*
405
FORMAT MODULE
408
GRAYSCALE CHARACTERISTIC HOLDING MODULE
409
TINCTURE CONVERSION TABLE HOLDING MODULE
410
CHROMATICITY LINE TABLE HOLDING MODULE
406
PROFILE ACQUISITION MODULE
407
TINCTURE ADJUSTMENT VALUE SETTING MODULE

FIG. 5

GL	L*
0	xx.x
16	xx.x
32	xx.x
•	•
•	•
•	•
•	•
•	•
255	xx.x

FIG. 6

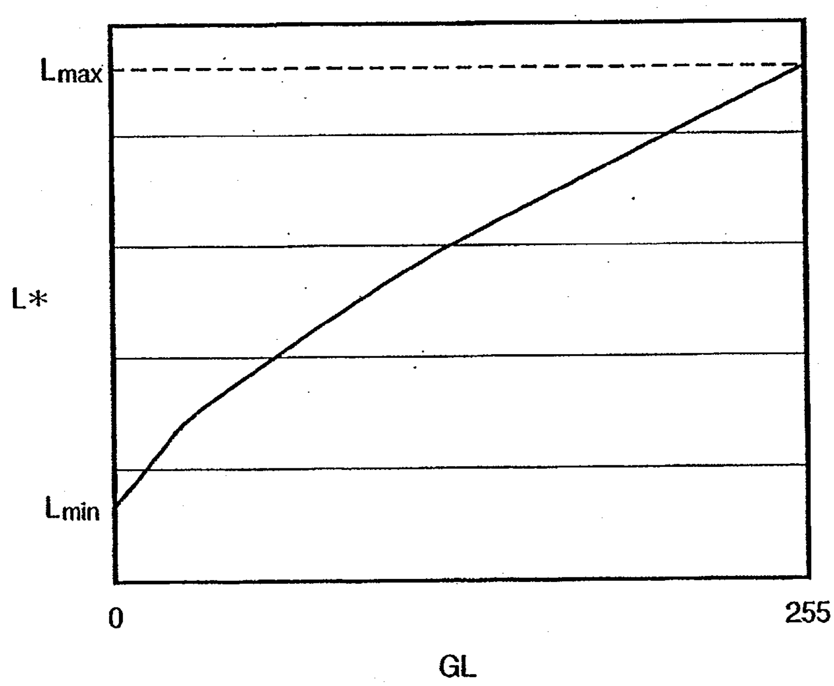


FIG. 7

L*	I
xx.x	xx.x
xx.x	xx.x
xx.x	xx.x
•	•
•	•
•	•
•	•
•	•
xx.x	0.0

FIG. 8

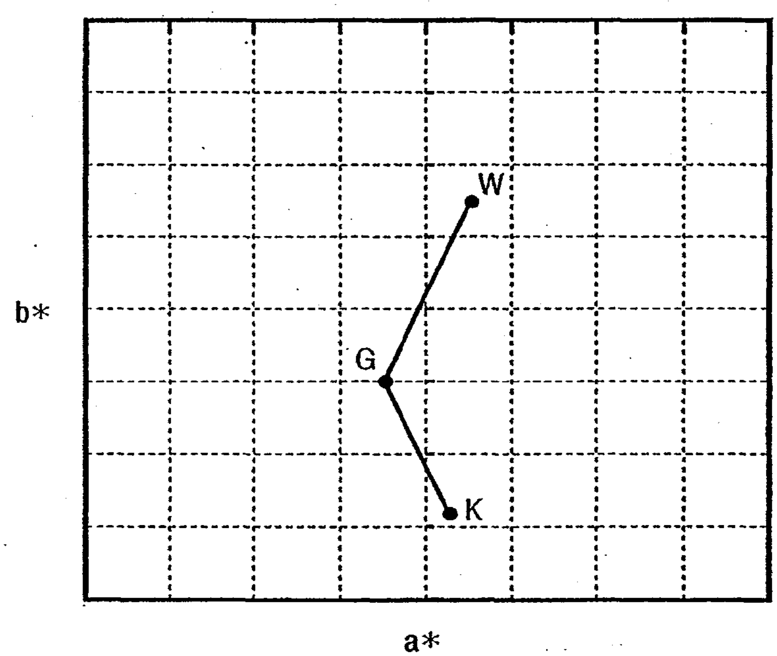


FIG. 9

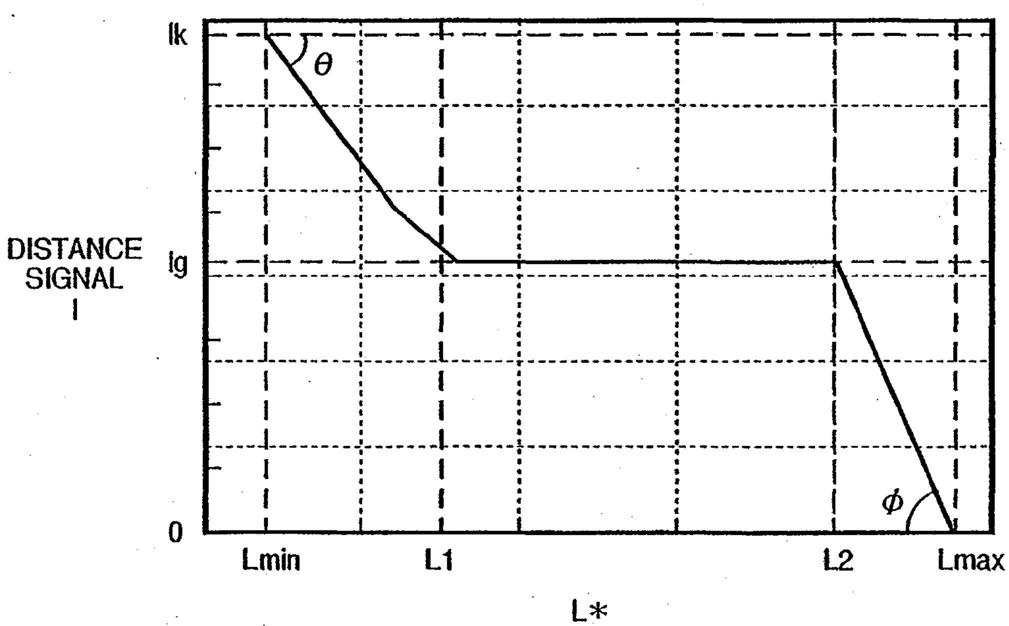


FIG. 10

l	a*	b*
0	x.x	x.x
0.2	x.x	x.x
0.4	x.x	x.x
•	•	•
•	•	•
•	•	•
•	•	•
•	•	•
x.x	x.x	x.x

FIG. 11

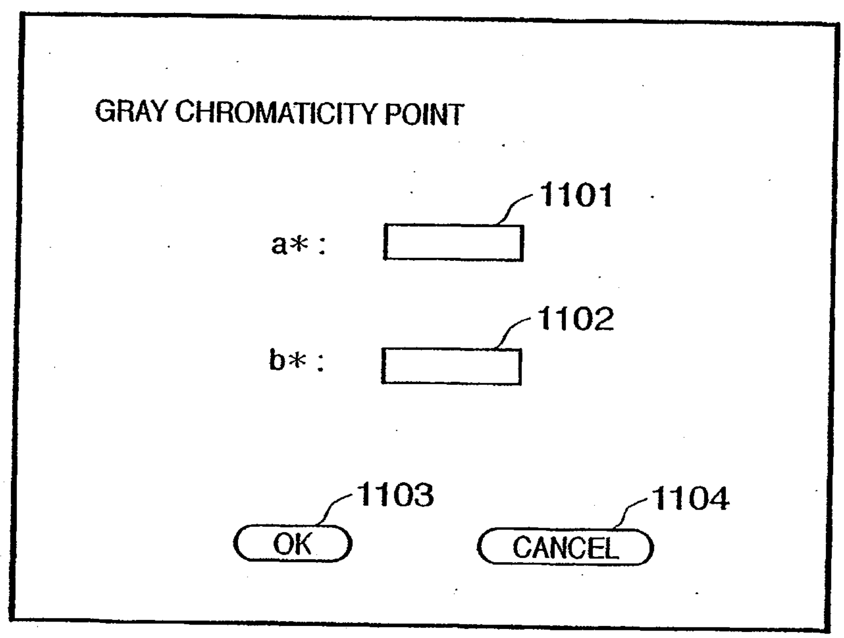


FIG. 12

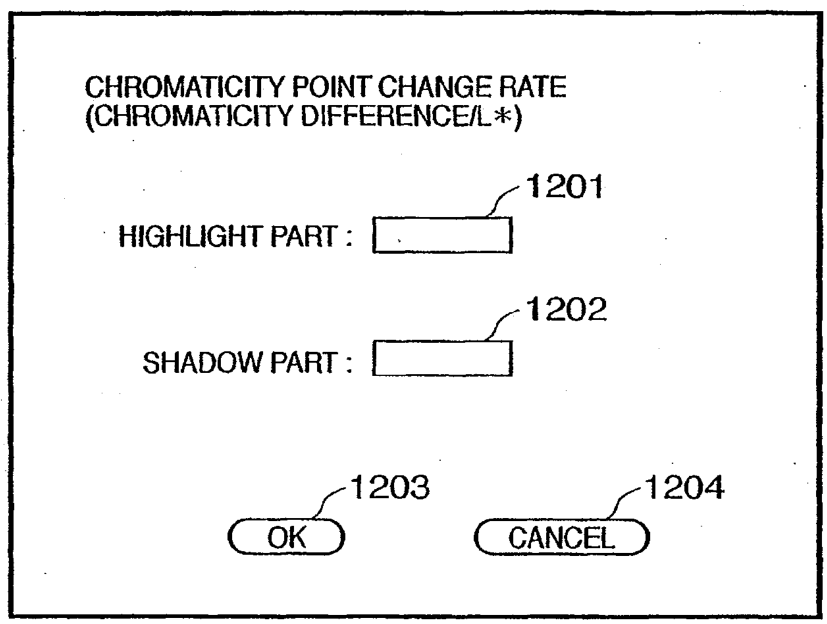
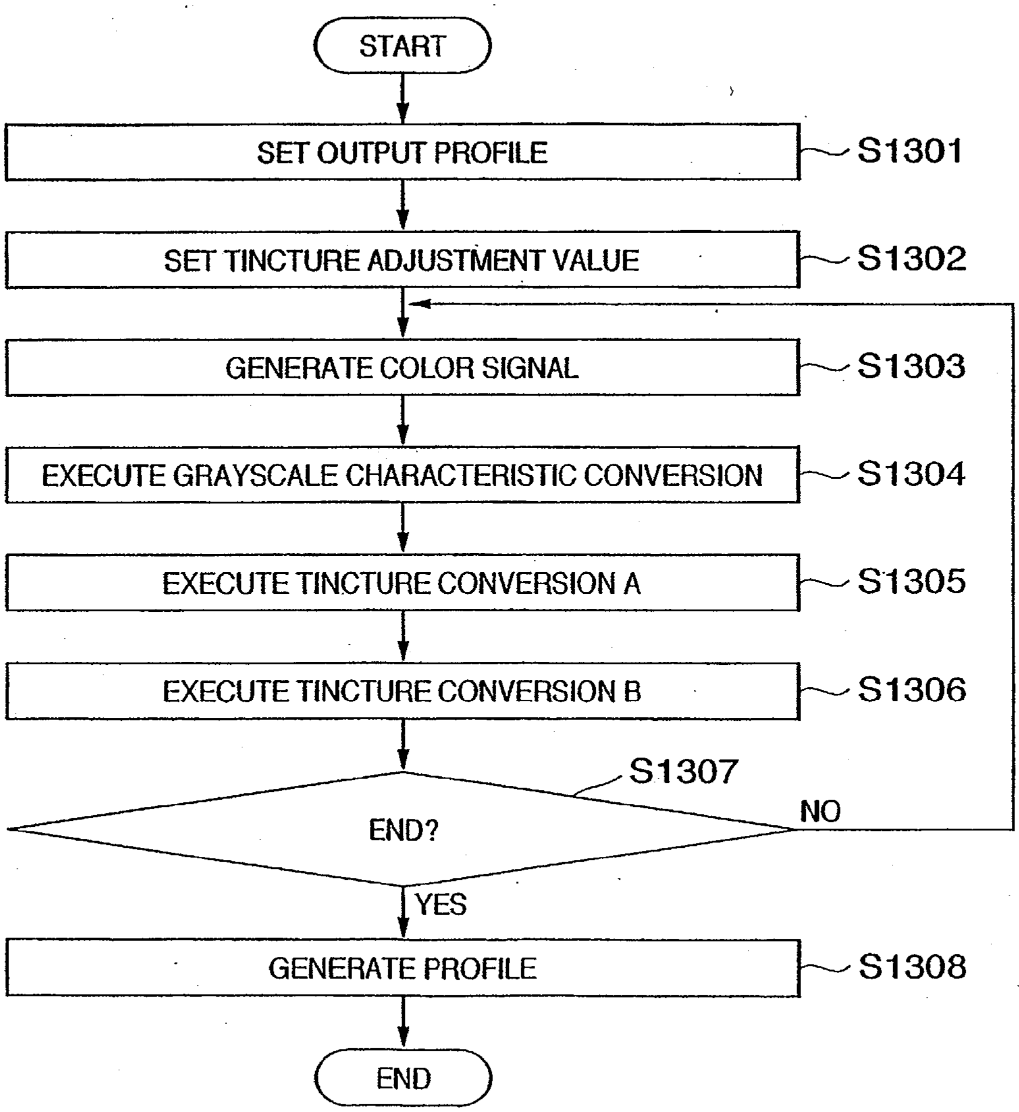

CHROMATICITY POINT CHANGE RATE
(CHROMATICITY DIFFERENCE/L*)
1201
HIGHLIGHT PART :
1202
SHADOW PART :
1203
OK
1204
CANCEL

FIG. 13



START
SET OUTPUT PROFILE
S1301
SET TINCTURE ADJUSTMENT VALUE
S1302
GENERATE COLOR SIGNAL
S1303
EXECUTE GRAYSCALE CHARACTERISTIC CONVERSION
S1304
EXECUTE TINCTURE CONVERSION A
S1305
EXECUTE TINCTURE CONVERSION B
S1306
S1307
END?
NO
YES
GENERATE PROFILE
S1308
END

FIG. 14

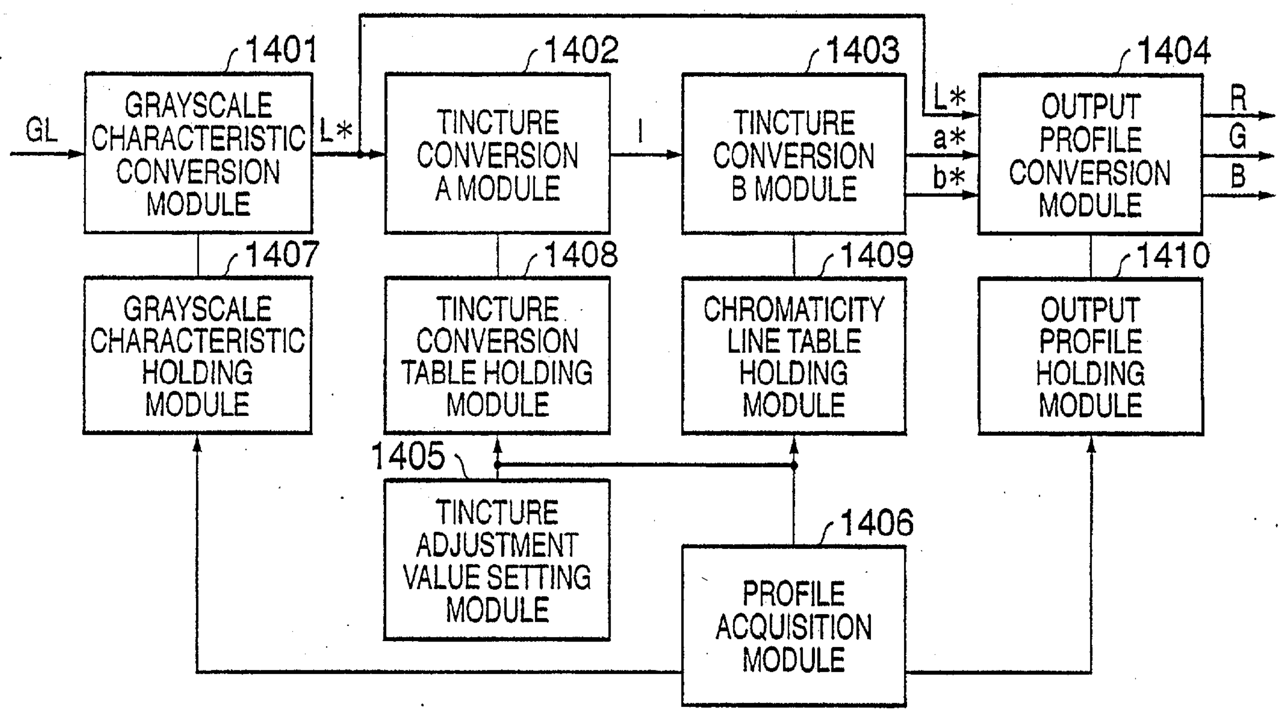
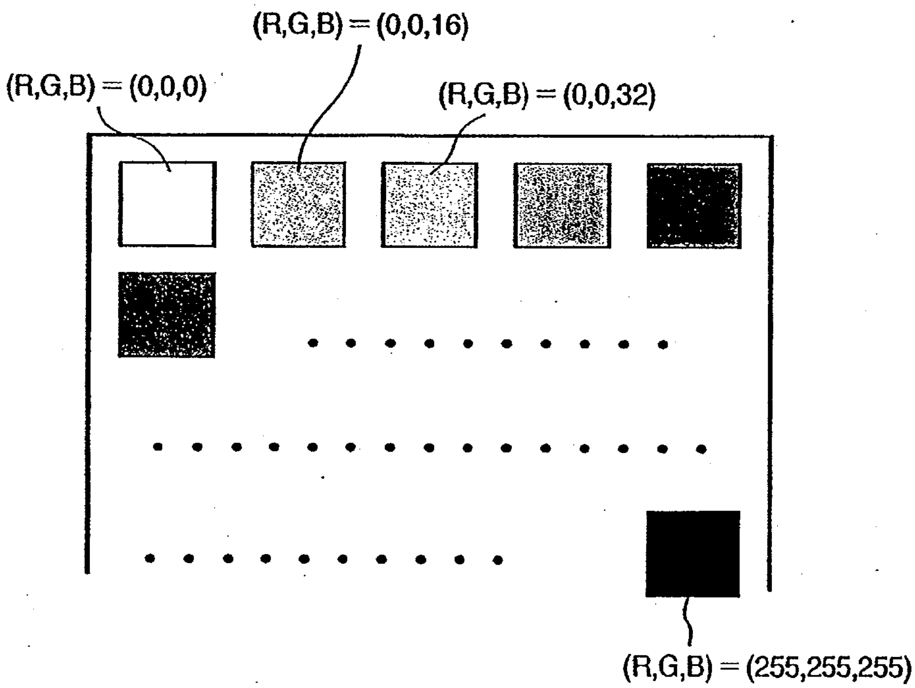

GL
1401
GRAYSCALE CHARACTERISTIC CONVERSION MODULE
L*
1402
TINCTURE CONVERSION A MODULE
I
1403
TINCTURE CONVERSION B MODULE
L*
a*
b*
1404
OUTPUT PROFILE CONVERSION MODULE
R
G
B
1407
GRAYSCALE CHARACTERISTIC HOLDING MODULE
1408
TINCTURE CONVERSION TABLE HOLDING MODULE
1409
CHROMATICITY LINE TABLE HOLDING MODULE
1410
OUTPUT PROFILE HOLDING MODULE
1405
TINCTURE ADJUSTMENT VALUE SETTING MODULE
1406
PROFILE ACQUISITION MODULE

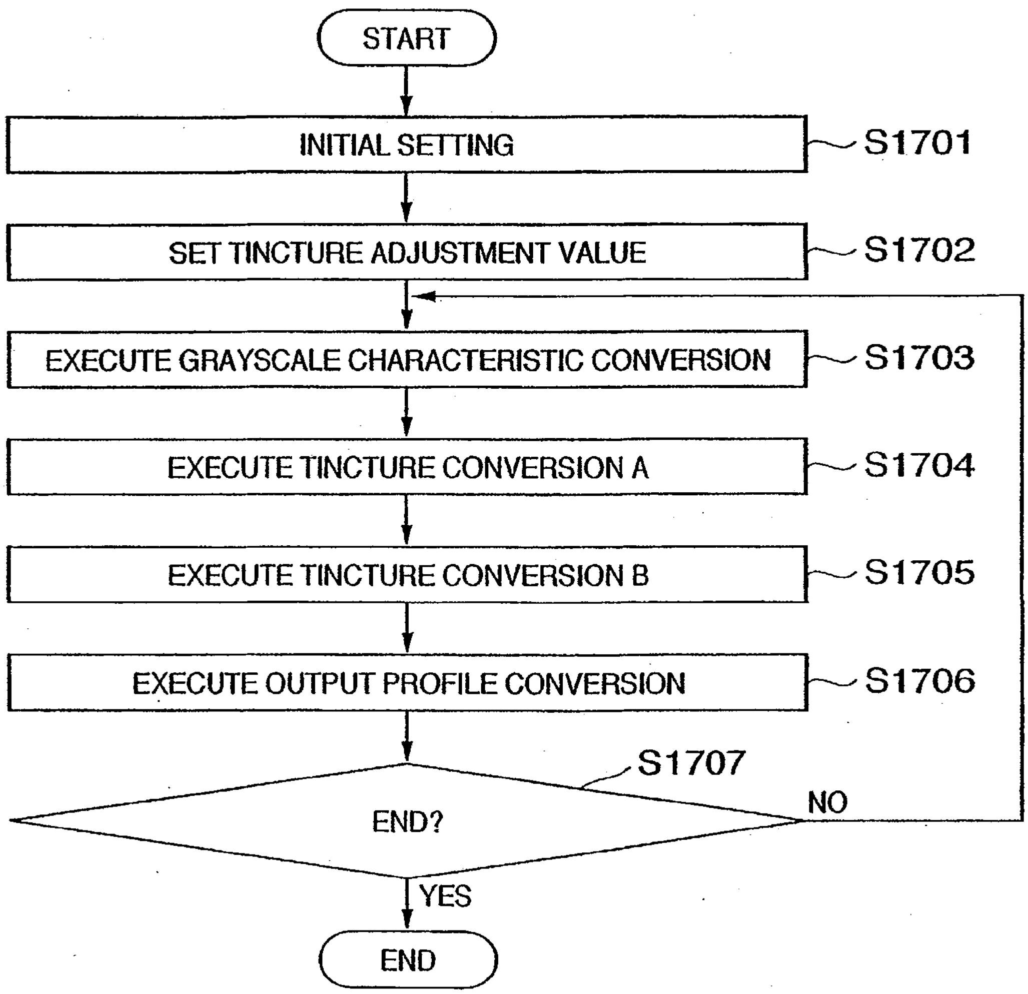
FIG. 15

R	G	B	L*	a*	b*
0	0	0	x.x	x.x	x.x
0	0	16	x.x	x.x	x.x
•	•	•	x.x	x.x	x.x
0	0	255	•	•	•
0	16	0	•	•	•
•	•	•	•	•	•
•	•	•	•	•	•
•	•	•	•	•	•
255	255	255	x.x	x.x	x.x

FIG. 16



F I G. 17



START
INITIAL SETTING
S1701
SET TINCTURE ADJUSTMENT VALUE
S1702
EXECUTE GRAYSCALE CHARACTERISTIC CONVERSION
S1703
EXECUTE TINCTURE CONVERSION A
S1704
EXECUTE TINCTURE CONVERSION B
S1705
EXECUTE OUTPUT PROFILE CONVERSION
S1706
S1707
END?
NO
YES
END

FIG. 18

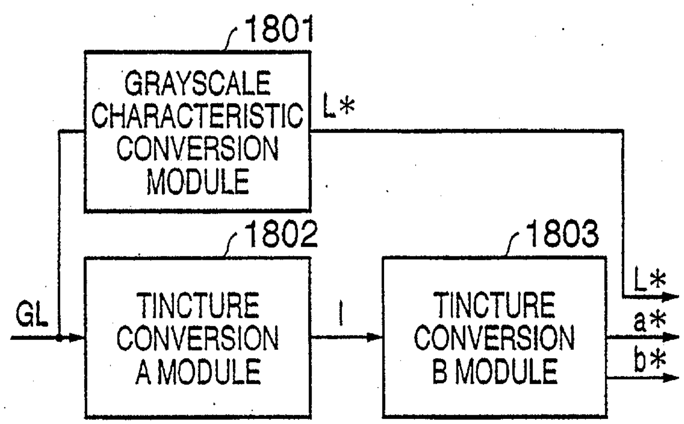

1801
GRAYSCALE CHARACTERISTIC CONVERSION MODULE
L*
1802
TINCTURE CONVERSION A MODULE
1803
TINCTURE CONVERSION B MODULE
GL
I
L*
a*
b*

FIG. 19

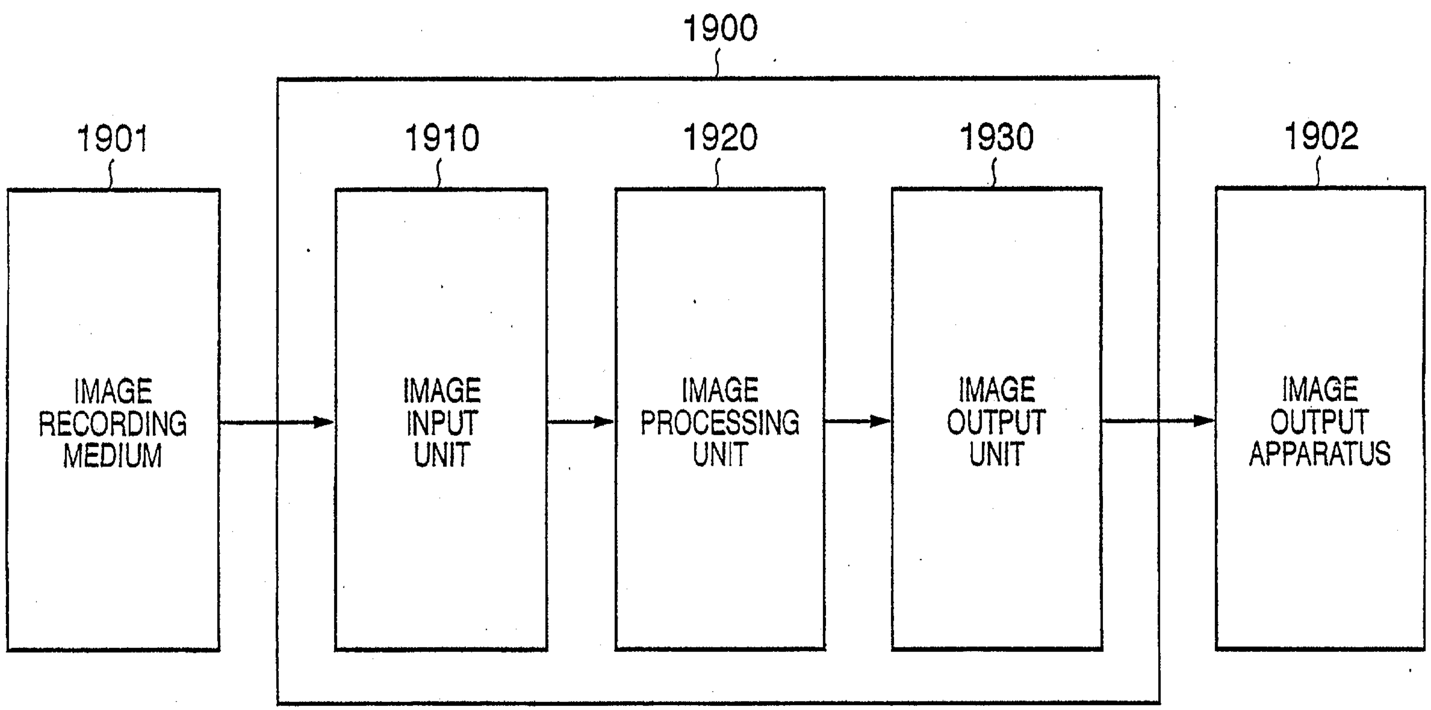
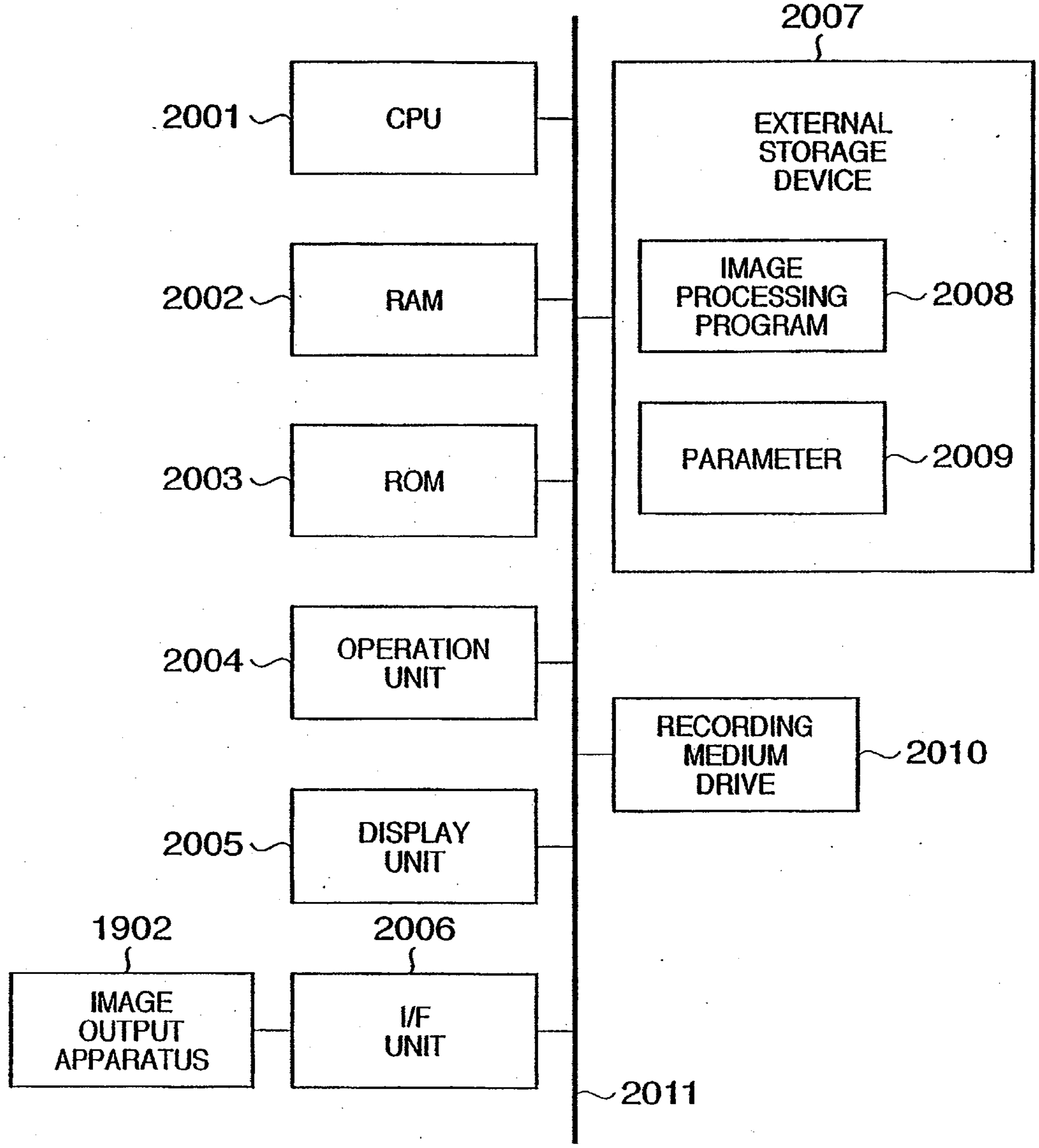
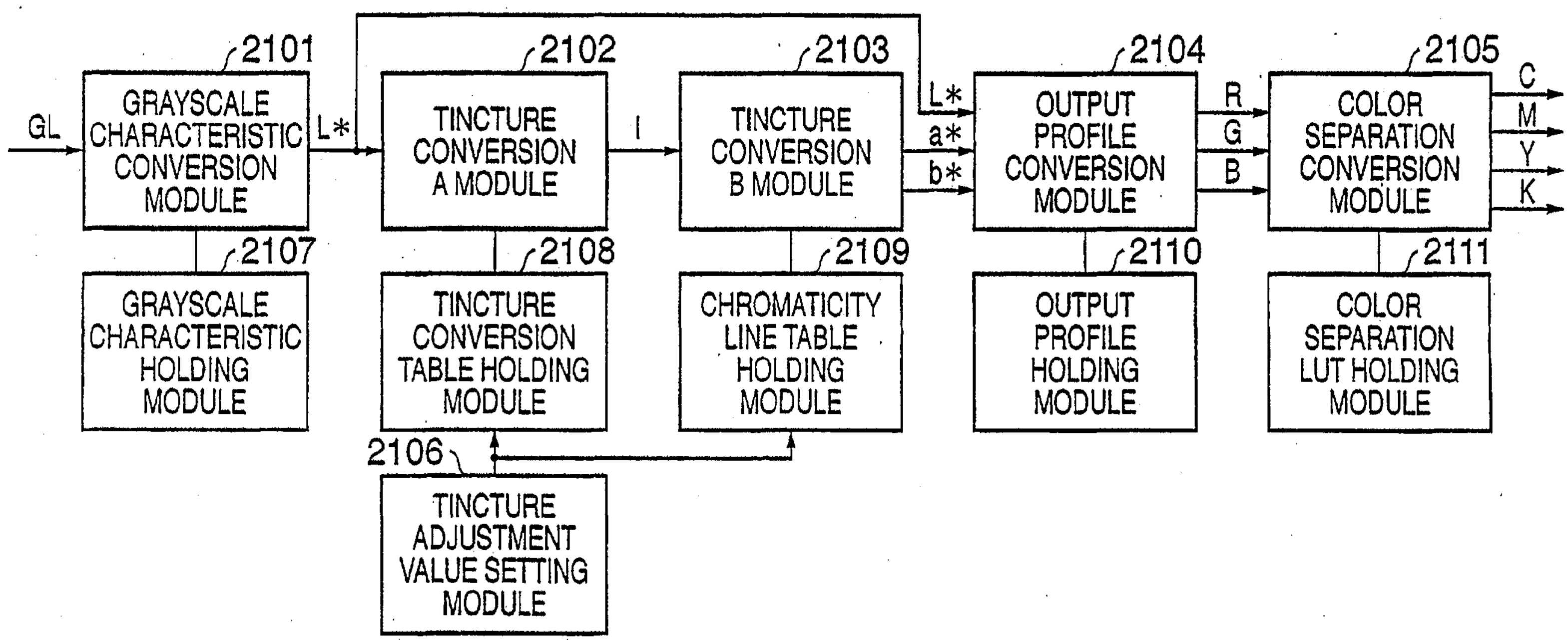

1900
1901
IMAGE RECORDING MEDIUM
1910
IMAGE INPUT UNIT
1920
IMAGE PROCESSING UNIT
1930
IMAGE OUTPUT UNIT
1902
IMAGE OUTPUT APPARATUS

FIG. 20



2007
EXTERNAL STORAGE DEVICE
2001
CPU
2002
RAM
2003
ROM
2004
OPERATION UNIT
2005
DISPLAY UNIT
1902
IMAGE OUTPUT APPARATUS
2006
I/F UNIT
IMAGE PROCESSING PROGRAM
2008
PARAMETER
2009
RECORDING MEDIUM DRIVE
2010
2011

FIG. 21



GL
2101
GRAYSCALE CHARACTERISTIC CONVERSION MODULE
L*
2102
TINCTURE CONVERSION A MODULE
I
2103
TINCTURE CONVERSION B MODULE
L*
a*
b*
2104
OUTPUT PROFILE CONVERSION MODULE
R
G
B
2105
COLOR SEPARATION CONVERSION MODULE
C
M
Y
K
2107
GRAYSCALE CHARACTERISTIC HOLDING MODULE
2108
TINCTURE CONVERSION TABLE HOLDING MODULE
2109
CHROMATICITY LINE TABLE HOLDING MODULE
2110
OUTPUT PROFILE HOLDING MODULE
2111
COLOR SEPARATION LUT HOLDING MODULE
2106
TINCTURE ADJUSTMENT VALUE SETTING MODULE

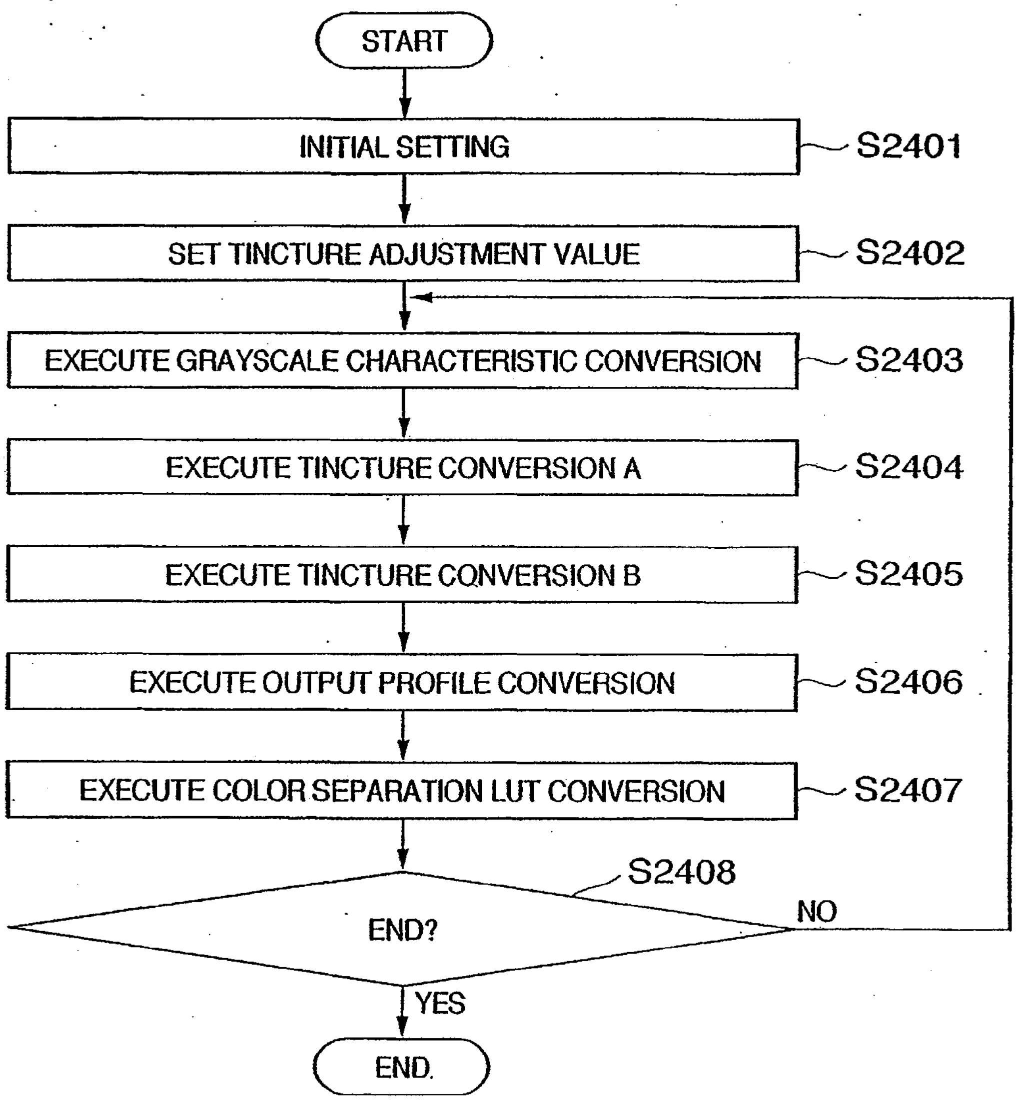
FIG. 22

R	G	B	L*	a*	b*
0	0	0	x.x	x.x	x.x
0	0	16	x.x	x.x	x.x
•	•	•	x.x	x.x	x.x
0	0	255	•	•	•
0	16	0	•	•	•
•	•	•	•	•	•
•	•	•	•	•	•
•	•	•	•	•	•
255	255	255	x.x	x.x	x.x

FIG. 23

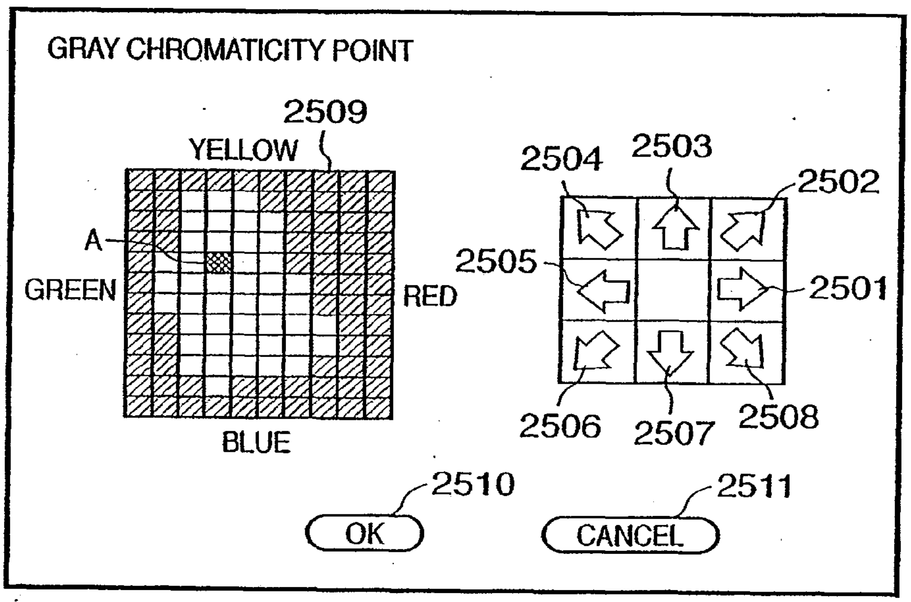
R	G	B	C	M	Y	K
0	0	0	X.X	X.X	X.X	X.X
0	0	16	X.X	X.X	X.X	X.X
•	•	•	X.X	X.X	X.X	X.X
0	0	255	•	•	•	•
0	16	0	•	•	•	•
•	•	•	•	•	•	•
•	•	•	•	•	•	•
•	•	•	•	•	•	•
255	255	255	X.X	X.X	X.X	X.X

F I G. 24



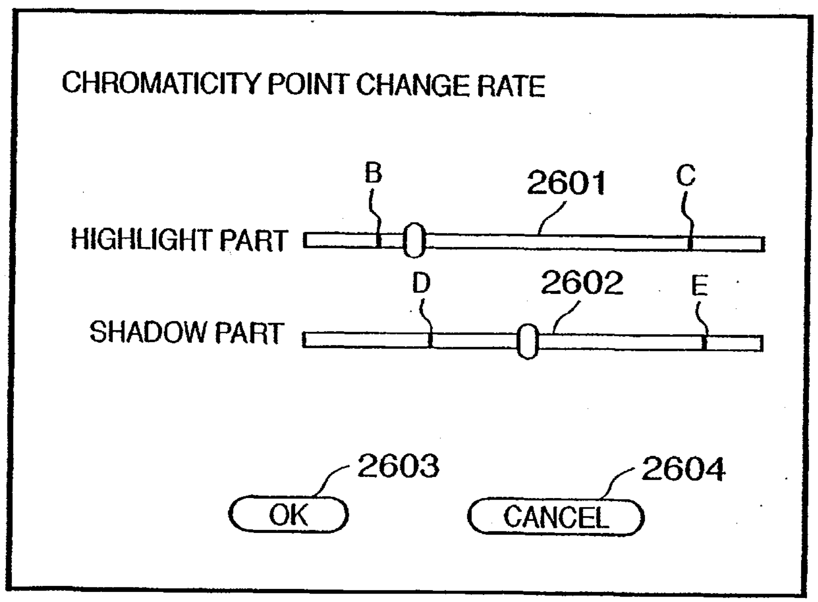
START
INITIAL SETTING
S2401
SET TINCTURE ADJUSTMENT VALUE
S2402
EXECUTE GRAYSCALE CHARACTERISTIC CONVERSION
S2403
EXECUTE TINCTURE CONVERSION A
S2404
EXECUTE TINCTURE CONVERSION B
S2405
EXECUTE OUTPUT PROFILE CONVERSION
S2406
EXECUTE COLOR SEPARATION LUT CONVERSION
S2407
S2408
END?
NO
YES
END

F I G. 25



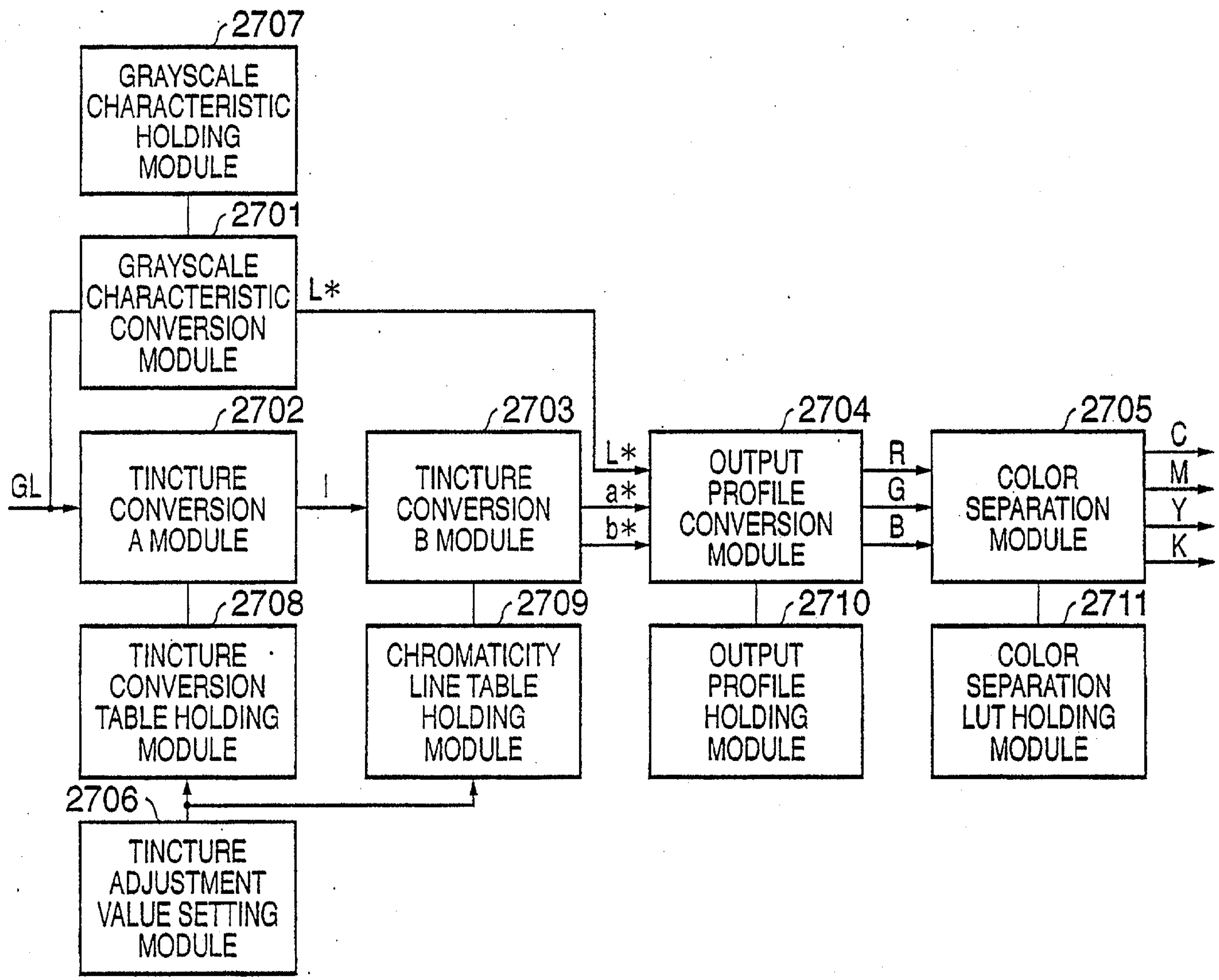
GRAY CHROMATICITY POINT
2509
YELLOW
A
GREEN
RED
BLUE
2504
2503
2502
2505
2501
2506
2507
2508
2510
OK
2511
CANCEL

FIG. 26



CHROMATICITY POINT CHANGE RATE
B
2601
C
HIGHLIGHT PART
D
2602
E
SHADOW PART
2603
OK
2604
CANCEL

FIG. 27


2707
GRAYSCALE CHARACTERISTIC HOLDING MODULE
2701
GRAYSCALE CHARACTERISTIC CONVERSION MODULE
L*
GL
2702
TINCTURE CONVERSION A MODULE
I
2703
TINCTURE CONVERSION B MODULE
L*
a*
b*
2704
OUTPUT PROFILE CONVERSION MODULE
R
G
B
2705
COLOR SEPARATION MODULE
C
M
Y
K
2708
TINCTURE CONVERSION TABLE HOLDING MODULE
2709
CHROMATICITY LINE TABLE HOLDING MODULE
2710
OUTPUT PROFILE HOLDING MODULE
2711
COLOR SEPARATION LUT HOLDING MODULE
2706
TINCTURE ADJUSTMENT VALUE SETTING MODULE

[Type of the Document] Abstract

[Abstract]

[Problem] Converting monochrome image data into color image data that can be printed with a desired tincture without biasing colors upon printing the monochrome image data by a designated image output apparatus.

[Solving Means] Setting a tincture adjustment value used to adjust the monochrome signal to a desired tincture of a user by a tincture adjustment value setting module; generating a tincture conversion table stored in a tincture conversion table holding module 1408 and a chromaticity line table stored in a chromaticity line table holding module 1409, based on the set tincture adjustment value and a profile for an image output apparatus acquired by a profile acquisition module 1406; converting a lightness signal L* corresponding to input monochrome signals into distance signals l on a chromaticity line in a tincture conversion A module 1402, using the converted tables; converting the distance signals l into chromaticity signals a* and b* in a tincture conversion B module 1403; and converting the lightness signal L* and chromaticity signals a* and b* into color signals for an image output apparatus in an output profile conversion module 1404.

[Selected Drawing] Fig. 14